1

POTENTIAL IMPROVEMENTS IN THE LOGISTICS ACQUISITION PROCESS OF THE EUROPEAN FIGHTER AIRCRAFT: AN ITALIAN PERSPECTIVE

THESIS

Pierluigi Ciardelli, Lt Col, IAF

AFIT/GLM/LSM/91S-9

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GLM/LSM/91S-9

1

POTENTIAL IMPROVEMENTS IN THE LOGISTICS ACQUISITION PROCESS OF THE EUROPEAN FIGHTER AIRCRAFT: AN ITALIAN PERSPECTIVE

THESIS

Pierluigi Ciardelli, Lt Col, IAF

AFIT/GLM/LSM/91S-9

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information are contained therein. Furthermore, the views expressed in the document are those of the author and do not necessarily reflect the views of the Italian Air Force, the Italian Ministry of Defense, the United States Air Force, the Department of Defense, or any other government agency.

AFIT/GLM/LSM/91S-9

POTENTIAL IMPROVEMENTS IN THE LOGISTICS ACQUISITION PROCESS OF THE EUROPEAN FIGHTER AIRCRAFT: AN ITALIAN PERSPECTIVE

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Pierluigi Ciardelli

Lieutenant Colonel, IAF

September 1991

Preface

The original objective of my study was to develop a model to improve the implementation of the Integrated Logistics Support (ILS) concept and the application of the Logistics Support Analysis (LSA) tasks during the current acquisition of the European Fighter Aircraft (EFA) by the Italian Air Force (IAF). I focused my research on the USAF experience in acquisition logistics and the lessons learned from the European TORNADO program in the area of support. I was not able to find a successful model ready to be introduced in the IAF, but I identified and discussed some actual recommendations for the EFA program, and some general guidelines applicable to the wider IAF acquisition logistics environment.

I wish to thank all of the individuals who made this effort possible. I thank my advisor, Dr. Craig M. Brandt, for his expertise, advice, and dedication. I am grateful for the patience, time, and knowledge given by Mr. Louis Benevides and Mrs. Andrea Wright of ALD/LSA, and for the availability and courtesy of the ATF SPO personnel. Special acknowledgements are needed to my friend and colleague Lt Col Armando Bonavoglia (IAF) who acted as focal point for all overseas information. Final thanks must go to my wife, Tiziana, and my daughter, Chiara, for all their support and understanding while I worked on this effort.

Pierluigi Ciardelli

Table of Contents

Page

List of Tables

List of Abbreviations and Acronyms

AAL	Additional Authorization List
ACA	Agile Combat Aircraft
ADP	Automated Data Processing
ADV	Air Defense Variant
AECMA	Aircraft European Contractors Manufacturers Association
AGE	Aerospace Ground Equipment
AFALC	Air Force Acquisition Logistics Center
AFALD	Air Force Acquisition Logistics Division
AFB	Air Force Base
AFCC	Air Force Communication Command
AFIT	Air Force Institute of Technology
AFLC	Air Force Logistics Command
AFLCP	Air Force Logistics Command Pamphlet
AFOTEC	Air Force Operational Test and Evaluation Center
AFSC	Air Force Systems Command
AFSPACECOMM	Air Force Space Command
AIT	Aeritalia
ALD	Acquisition Logistics Division
ASD	Aeronautical Systems Division
ATC	Air Training Command
ATF	Advanced Tactical Fighter
ATOS	Automated Technical Order System
BAe	British Aerospace
BII	Basic Issue Item
CALS	Computer-aided Acquisition and Logistics Support
CASA	Construcciones Aeronauticas of Spain
CATSP	Computer-Aided Tailoring Software Program
CDRL	Contract Data Requirement List
COEI	Components of End Items
CSDB	Common Source Data Base
DLSC	Defense Logistics Services Center
DMMIS	Depot Maintenance Management Information System
DOD	Department of Defense
DODD	Department of Defense Directive
DPML	Deputy Program Manager for Logistics
DSE	Developmental Supportability Engineering
DSMC	Defense System Management College
DSS	Decision Support System
DTIC	Defense Technical Information Center

EAP	Experimental Aircraft Programme
ECA	European Combat Aircraft
ECR	Electronic Combat Reconnaissance
EFA	European Fighter Aircraft
EPS	Enhanced Procurement System
ESML	Expandable/Durable Supplies and Materials List
ESR-D	European Staff Requirement - Development
FH	Flight Hour
FMECA	Failure Mode, Effects, and Criticality Analysis
FOB	Forward Operating Base
FR	France
FY	Fiscal Year
GE	Germany
HAS	Hardened Aircraft Shelter
IAF	Italian Air Force
IAFFT	International Air Forces Field Team
ILDF	Integrated Logistics Data File
ILS	Integrated Logistics Support
IP	Initial Provisioning
IPMIS	Initial Provisioning Management Information System
ISD	In-Service Date
IT	Italy
IWSDB	Integrated Weapon System Data Base
JS	Joint Service
LCC	Life Cycle Cost
LCN	LSA Control Number
LOGPARS	Logistics Planning and Requirements Simplification System
LRI	Line Replaceable Item
LSA	Logistics Support Analysis
LSAD	Logistics Support Analysis Documentation
LSAR	Logistics Support Analysis Record
LSD	Logistics Support Date

M	Maintainability
MAC	Military Airlift Command
MANPRINT	Manpower Personnel Integration
MBB	Messerschmitt-Bolkow-Blohm
MCCR	Mission Critical Computer Resources
MIL	Military
MMH	Maintenance Man Hour
MOD	Ministry of Defense
MOU	Memorandum of Understanding
MRCA	Multi-Role Combat Aircraft
NAMMA	NATO MRCA Development and Production Management Agency
NATO	North Atlantic Treaty Organization
NEFMA	NATO European Fighter Development, Production and Logistics Management Agency
PM	Program Manager
PMRT	Program Management Responsibility Transfer
PPLI	Provisioning Parts List Index
PS	Phased Support
R	Reliability
RAF	Royal Air Force
RCM	Reliability Centered Maintenance
RR	Rolls Royce
SAC	Strategic Air Command
SAIP	Spares Acquisition Integrated with Production
SDR	System Design Responsibility
SE	Support Equipment
SERD	Support Equipment Recommendation Data
SIL	Software Integration Laboratory
SMR	Source, Maintenance, and Recoverability
SOW	Statement of Work
SP	Spain
SPO	System Program Office
STD	Standard
STOL	Short Take-Off Landing
T	Testability
TAC	Tactical Air Command
TMDE	Test Measurement and Diagnostic Equipment
UK	United Kingdom
USA	United States of America
USAF	United States Air Force

VAMOSC	Visibility and Management of Operating and Support Cost
WSDPS	Weapon System Design and Performance Specification

AFIT/GLM/LSM/91S-9

Abstract

This thesis was aimed at developing recommendations to improve the implementation of the Integrated Logistics Support (ILS) concept and the application of the Logistics Support Analysis (LSA) tasks during the current acquisition of the European Fighter Aircraft (EFA) by the Italian Air Force (IAF).

The research was conducted through a wide overview of the ILS philosophy and implementation, specifically focusing on the USAF experience in acquisition logistics and the lessons learned from the European TORNADO program in the area of support.

Although a successful model ready to be introduced in the IAF was not found, some recommendations for the EFA program and some general guidelines applicable to the wider IAF acquisition logistics environment were identified and discussed. The aspects related to the personnel education in acquisition logistics, the computerization of all support functions, the emphasis on ILS contracting, and the integration of different logistics standards were the most significant findings applicable to the IAF.

POTENTIAL IMPROVEMENTS IN THE LOGISTICS ACQUISITION PROCESS OF THE EUROPEAN FIGHTER AIRCRAFT: AN ITALIAN PERSPECTIVE

I. Introduction

Background

In the last three decades technology made great strides that determined higher complexity of systems and products and increased demand for logistics requirements. In particular the acquisition of a new weapon system has become a more and more critical issue for every nation. Costs associated with the acquisition of the systems have grown significantly, but what is more alarming is that the operating and support costs have increased at higher rate, reaching unexpected and really worrying figures (6:xv).

The approach to the costs in terms of the full life-cycle of the system has become mandatory. "Logistics has assumed a major role comparable to research, design, production, and system performance during operational use" (6:xv-xvi) not only because the operating and support costs "frequently consume more than 50% of a system's total life cycle costs" (1:2), but also because studies and experience have indicated that logistics support planning must start at the very beginning of an acquisition program. Decisions made during the early stages of the process determine almost completely the total life cycle costs: by the end of the full scale development, up to 80-95% of future expenditures have already been locked in (1:2, 32:13).

In addition to the rising costs of weapons, most of the European nations are fac[illegible] the need to reduce their military expenditures [illegible] for political and economic reasons, and for changing priority in allocation of limited financial resources. The sudden unification of West and East Germany, the current transformation in most of the communist countries, the vague definition of the traditional military threat, and the new common European market without borders of 1992 are only the most evident and recent reasons of a dynamic and uncertain situation.

In this scenario Italy is living a period of significant cuts in the Ministry of Defense (MOD) budget that, combined with renewed inflationary trends, results in a stringent resource-constrained environment. It is therefore essential these limited resources be used in the most efficient manner to maintain force readiness.

The non cited information contained in this introduction and in Chapter III comes from the author's direct experience acquired while participating in international working groups and panels of the TORNADO (1984-1987) and the European Fighter Aircraft (EFA) (1988-1990) projects as a representative of the Italian MOD.

The first priority and most expensive program in the next few years of the Italian Air Force (IAF) is the acquisition of the EFA, the new air defense vector that should be fully operative in the NATO air defense system in 1999, three years after its in-service date (ISD) (39:2).

Economic reasons, industrial growth and capability, and positive results of previous experience have induced the same nations of the TORNADO project - Great Britain (UK), Germany (GE), and Italy (IT) -, together with Spain (SP), to decide on developing EFA entirely within industries in the participant countries. Two industrial consortia for aircraft and engine (Eurofighter and Eurojet respectively) and a NATO management agency (NEFMA) were established. Complex fixed-price development contracts were signed in November 1988, based on a cost sharing policy that eventually will allocate work and costs among the four nations following the share of 33% for both UK and GE, 21% for Italy and 13% for Spain (39:1).

This is the first project in Europe where the Integrated Logistics Support (ILS) concept has been contractually imposed on industries throughout the whole acquisition process. The four nations have clearly specified in the contractual documentation that logistics support has to be considered at the same level as system performance, able to influence design where necessary (35:2).

Statement of the Problem

The formulation of a well defined logistics support concept (35), together with the operational requirements, was difficult to accomplish for the EFA.

Among the several technical problems faced by the nations in this phase were the following:

- different logistics requirements;
- different allocation of responsibilities in the central organization of the MODs and the air forces;
- different existing national logistics structure and network;
- different level of logistics knowledge and experience of national industries.

At the same time, the participation in research and development programs of single equipment with American partners and the recent experience gained by UK in the update of existing systems with the application of the ILS contributed to drive the formulation of the contractual logistics requirements in the direction of a global approach to the support of the weapon system.

The decision to abandon the consolidated and traditional support concept and methodology in favor of the ILS philosophy was also influenced by the TORNADO support costs recorded by NAMMA - the NATO management agency for this aircraft - that clearly indicated duplication of costs among the different logistics functions.

In this context the IAF is running a risk in not taking advantage of the application of ILS because it is not prepared to take its first steps in this new environment where close collaboration with industry is essential and knowledge of lessons learned by other air forces could be beneficial.

The IAF needs to investigate whether or not the United States Air Force (USAF) overcame similar difficulties in the past and how it is now implementing an ILS philosophy in major weapon system acquisition projects.

Objective of the Study

The objective of this study is to develop recommendations to improve the implementation of the ILS concept and the application of the Logistics Support Analysis (LSA) tasks for the EFA in the IAF.

The review of the classical theory of ILS and LSA, and the research of the experience of the USAF in past and current acquisition programs have been combined with the analysis of the lessons learned from the traditional logistics approach of the TORNADO project in order to provide some suggestions that the IAF could take into consideration not only in the further steps of the EFA program, but also during the continuous process of logistics policy updating.

Under this perspective, the study should also remind the IAF executive managers that the concepts of ILS, LSA and Life Cycle Cost (LCC) cannot be effective if support considerations lack management priority. If acquisition programs persist in giving top priorities to cost, schedule, and performance objectives, support and readiness aspects will continue to suffer within programs' constraints (29:2).

Methodology

The procedure for conducting this study was an archival, or documentary, research. No new data were generated, but existing data were gathered and processed, under the clear perspective determined by the objective of the research.

The first step was the review of current DOD and USAF regulations in order to have the basis for a comparison of the theoretical ILS policy and LSA tasking requirements with the actual implementation within the Advanced Tactical Fighter (ATF) System Program Office (SPO) located at Wright-Patterson Air Force Base.

Research of military and related periodicals of the past ten years was conducted to outline specific expert comments and recommendations that could help better understand the practical applications of the ILS approach and the actual weight given by industry to this issue.

Defense Technical Information Center (DTIC) studies and Air Force Institute of Technology (AFIT) theses focused on the ILS concept and the LSA implementation were reviewed to verify whether and to what extent data and information on past problems and relative proposal solutions are applicable to the Italian needs and conditions.

The logistics part of the EFA development contracts was carefully studied to present the peculiarities of the EFA project in terms of logistics support concept, maintenance concept, and supply support concept. This analysis was essential to exactly identify what the participating nations could expect from industry, and what should be added to the logistics parts of the production contractual documents.

The Acquisition Logistics Division (ALD) lessons learned data base, created with "the task of gathering, validating, storing and disseminating lessons within the Air Force" (2:i), provided a source of management and technical experience, able to promptly document problems and actions in each area of the ILS.

The study conducted in 1986 by the LSA/LSAR Acquisition Review Group within the USAF (14) was another useful source: it describes in depth how the LSA/LSAR process affects the USAF ability to field supported weapon systems.

Finally, the TORNADO project was analyzed from a logistics point of view. Difficulties experienced by the IAF in the logistics management of the TORNADO program, developed in an international and industrial environment almost identical to the EFA's environment, outlined the main problems encountered following the traditional logistics approach and indicated how most of these deficiencies should be avoided in the EFA program with the introduction of the ILS philosophy.

II. ILS Review

The Classical Theory

The ILS Concept. DODD 5000.39 Acquisition and Management of Integrated Logistics Support for Systems and Equipment defines ILS as

> A disciplined, unified, and iterative approach to the management and technical activities necessary to:
> a. Integrate support considerations into system and equipment design.
> b. Develop support requirements that are related consistently to readiness objectives, to design, and to each other.
> c. Acquire the required support.
> d. Provide the support during the operational phase at minimum cost. (19:2-2)

DODD 5000.39 is implemented in the US Air Force by AFR 800-8 Integrated Logistics Support Program, which specifies that the objective of the ILS program is "to field weapon systems and equipment that achieve the required readiness and sustainability posture at an affordable life cycle cost" (13:1).

The ILS management function provides the initial planning, findings, and controls aimed at the achievement of a system that "can be economically supported throughout its programmed life cycle" (6:11).

ILS policy highlights the development of a total logistics structure that could ensure the integration of the various elements of support. To assist in implementing and managing the ILS concept, DODD 5000.39 identifies the ten basic elements of ILS that are briefly described as follows.

- Maintenance Planning is the process that establishes maintenance concepts and requirements for the life of the system. The maintenance plan specifies the levels of the maintenance tasks, the contractor support, and the standards for each level of support.
- Manpower and Personnel refers to the identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a system over its lifetime. Recruitment and retention are also included.
- Supply Support covers all management actions, procedures, and techniques related to secondary items, including provisioning for initial support as well as replenishment supply support.
- Support Equipment deals with all equipment, mobile or fixed, required to support the operation and maintenance of a system. Planning ensures needed items are either already in the field or created specifically.
- Technical Data is the recorded information of scientific and technical nature. It includes technical manuals, parts lists, and specifications listing.
- Training and Training Support refers to the processes, procedures, techniques, and training equipment used to train personnel to operate and support a system.
- Computer Resources Support represents the facilities, hardware, software, documentation, manpower, and

personnel needed to operate and support embedded computer systems.

- Facilities are all property assets required to support a system for training, maintenance, storage, and testing.
- Packaging, Handling, Storage, and Transportation are the resources, processes, procedures, design considerations, and methods to ensure that all systems, equipment, and support items are preserved, packaged, handled, and transported properly.
- Design Interface, finally, is the relationship of logistics-related design parameters, such as Reliability and Maintainability (R & M), to readiness and support *resource* requirements (8:32-33).

To achieve system readiness at an affordable Life Cycle Cost (LCC), the readiness and supportability objectives have to be early identified and translated into explicit design parameters. This integration with the design effort is accomplished through the Logistics Support Analysis (LSA).

The LSA Approach. The Logistics Support Analysis (LSA) is the core of the ILS implementation during the acquisition phase: it is the process of documenting the interface between engineering design and support requirements.

MIL-STD-1388-1A Logistics Support Analysis defines LSA as:

> The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other ILS objectives. (21:106)

This means that logistics engineering must be embraced within system engineering. The system engineering process transforms "an operational need into a description of system performance parameters and a preferred system configuration" (6:9), always looking at the system as a whole and under a top-down approach.

The goals of LSA are to:

a. Cause supportability requirements to be an integrated part of system requirements and design.
b. Define support requirements that are optimally related to the design and to each other.
c. Define the required support during the operational phase.
d. Prepare attendant data products. (21:iii)

Actually the LSA process identifies and evaluates the logistics support needed for a new system, aiding in the initial establishment of supportability requirements, in the evaluation of alternative design configurations of systems and equipment, in the determination of logistics support requirements for a given configuration, and in the final assessment of the system support capability during the operational use (6:140-143).

As AFLCP 800-17 Air Force Logistics Support Analysis Primer specifies, the LSA consists of

> a planned series of tasks performed to examine all elements of a proposed system to determine the logistics support required to keep that system usable for its intended purpose; and to influence the design

so that both the system and support can be provided at an affordable cost. (12:2)

These tasks, divided in five basic sections, can be grouped in three generic sets, in accordance with the functions they have. The first function of managing the LSA program is performed by the 100 tasks (program planning and control); the second function of analyzing and synthesizing the logistics support requirements is covered by the 200 tasks (mission and support systems definition), the 300 tasks (preparation and evaluation of alternatives), and the 400 tasks (determination of logistics support resource requirements); the third function of verifying the adequacy of the identified logistics support is accomplished by the 500 task (supportability assessment) (12:2-7). Globally, the mentioned five basic task sections are divided into 15 tasks that are further split into 77 subtasks that, being generic in nature, shall be tailored according to the program. Appendix A shows the list of all LSA tasks and subtasks of MIL-STD-1388-1A.

The LSA continues throughout the acquisition phase of the system; it must start in the pre-concept phase to provide logistics influence on design during the concept exploration and the demonstration and validation phases, and to identify the optimal logistics support resources during the full scale development and the production phases.

All information developed as a result of performing the tasks of MIL-STD-1388-1A is called LSA Documentation (LSAD) and "serves as the primary source of design related logistics support data for a system acquisition" (1:11). The procedures for documenting LSAD are specified in MIL-STD-1388-2A (20).

A subset of this documentation consists of plans, studies, and reports, whereas another subset of LSAD, called the Logistics Support Analysis Record (LSAR), provides

> a uniform, organized, and flexible technical data base which consolidates the engineering and logistics data necessary to identify the detailed logistics support requirements of a system. (12:33)

Formats and definitions of data elements on each data record are identified by MIL-STD-1388-2A. Although automation of the LSAR data is not mandatory, the maintenance of this data is always supported by an Automated Data Processing (ADP) system. The data resulting from each iteration of the LSA tasks is the input for the following analyses in the iterative LSA process. Appendix B shows the list of all LSA records and output reports mentioned in MIL-STD-1388-2A.

Areas of Interest in the ILS Implementation

A review of the ILS process among military and related periodicals of the past ten years has outlined some major areas on which US government and industries are currently focusing. A brief summary of these issues is extremely useful for the object of this study because it shows the real difficulties and deficiencies encountered in implementing the ILS concept.

Organizational Problems in Acquisition Logistics Management.

> A major objective of ILS management is to influence material system requirements and design to achieve and sustain established operational requirements while minimizing operating and support costs. (37:31)

This goal can be achieved only if the engineering and logistics aspects mature together from the beginning of the acquisition program.

The USAF usually separates responsibilities of obtaining and maintaining new weapon systems between two major commands: the Air Force Systems Command (AFSC) and the Air Force Logistics Command (AFLC). AFSC takes on the system implementing responsibilities (research, development and procurement), whereas AFLC takes on the support responsibilities. The program management responsibility transfer (PMRT) occurs during the production/deployment phase, when little flexibility remains for influencing the design and reducing operating and support costs. To solve the problems resulting from the lack of communication between these two organizations, the Air Force Acquisition Logistics Division (AFALD or, briefly, ALD), as a field organization of AFLC, was established in 1976, with the aim of creating a logistics interface between AFSC and AFLC.

ALD's mission is to increase the availability of weapon systems and reduce life cycle costs by

> assuring consideration of supportability, reliability and maintainability during the design, development, and production process of weapon system acquisition. (27:10)

Through ALD directorates located at the major AFSC product divisions, AFLC's responsibility begins early in the acquisition process, managing ILS planning activities and providing assistance in logistics disciplines (27:9-10).

Global policy reasons in accordance with the current restructuring phase of the USAF organization have determined the decision of merging AFSC and AFLC into a single materiel command during the year 1991. The aimed improvement in efficiency that is expected from the establishment of this new major command should affect the conduct of the USAF weapon system acquisition.

Difficulties in Influencing Design through LSA. System Engineering, as Jones and Walker outline, is

> a continual and iterative activity, with the output being the optimal balance between performance and support considerations and optimal trade-offs among costs of ownership, schedule and system effectiveness. (31:38)

Both design and ILS are subsets of the system engineering activities, with in common the LSA process, that brings together design and support concepts, using the LSAR as the primary means for data exchange (11:11).

Through the use of analytical techniques and models, LSA activities

> develop and evaluate alternative support concepts, project logistics support requirements, perform design trade-offs to optimize logistics supportability, perform trade-offs among the ILS elements, and provide assistance in influencing design. (37:31-32)

The problem stays in the real capacity of logistics managers to influence design. The LSA/LSAR process provides the needed instruments, especially through the analyses related to the reliability and maintainability aspects, which document the effect and criticality of an item failure and the results of the application of the reliability centered maintenance logic. The Failure Mode, Effects, and Criticality Analysis (FMECA), which identifies "the likely modes of failure, the possible effect of each failure, and the criticality to the mission success, safety, supportability or some other significant outcome" (18:4.4), is the starting point for the corrective maintenance program. On the other hand, the Reliability Centered Maintenance (RCM) analysis, being "a systematic way to determine the feasibility and desirability of preventive maintenance tasks" (18:4.4), establishes the basis for the preventive maintenance program and ensures the design accommodates the preventive maintenance.

Program managers and logistics managers must realize that they have the authority and the procedural mechanism to exert pressure on design (37:34).

The Acquisition Logistics Educational Problem. One of the major issues in effectively implementing the ILS process in the acquisition programs is the professional and technical qualification of all players in the acquisition business.

As Andrews states, people involved in acquisition logistics and ILS planning process need education; they must learn concepts and ideas, "emphasizing the understanding, comprehension, analysis, and application" (5:5) of logistics knowledge. The Program Manager is responsible for ILS, "the individual who balances the political realities of the program with cost, schedule, and system effectiveness" (31:14); he is the first who must be convinced of the power of ILS if he wants to trade-off support with other competing interests.

Not only do logisticians have to acquire a broader perspective of the logistics problems, going beyond their knowledge in a specialized logistics area, but so do design engineers, because they are the individuals who "play a major role in the determination and establishment of logistics requirements" (32:13).

The Air Force has undertaken several initiatives, among which the most remarkable is the establishment of an acquisition logistics major in the Air Force Institute of Technology's (AFIT) Graduate Logistics program, but the goal has still to be reached. The same can be said about the Defense Systems Management College (DSMC) in Washington that has restructured its curriculum to satisfy the need of the acquisition logistics education as a basis to influencing design (32:14-16).

Software Logistics: the New Element. The recent great steps in embedded computer technology have determined, in the last 10-15 years, an extremely high rate of increase in the number of software-based equipment installed in military aircraft and, consequently, an increase in software-based associated test and support equipment (22:23). This proliferation of microprocessors has affected logisticians, who still have to adapt the traditional hardware logistics concepts to the new software support.

Although in 1980 DOD identified computer resources support as a distinct element of ILS, doubts exist whether or not this support should be considered thoroughly integrated into the other ILS elements (33:155-156).

Among the main areas of software logistics, major problems are being experienced in the creation of software maintenance plans: software maintenance has such unique characteristics that efficient restoration is usually obtained with program modifications. In the same way, software modifications are necessary to satisfy performance improvement, to maintain compatibility after changes or modifications in the related hardware, to interface different components of the computing system when a hardware or software change has been introduced, and to solve internal deficiencies (33:156-157).

All these changes cause heavy effects on configuration management and retrofit engineering. Procedures and controls must be established by the ILS to avoid problems in these specific areas.

Training and documentation are two other ILS elements that are deeply affected. A real revolution in aircraft maintenance has already started because of the proliferation of embedded and support software.

Software reliability is different from hardware reliability. Engineers are presently attempting to determine when testing should end, what is the prediction of errors per numbers of line of codes, and what types of errors can be expected (22:24-25).

Finally, LSA for software is a large field that, despite considerable efforts in terms of time and money, is not yet documented in an official regulation.

The LSA/LSAR Enhancement Plan. As the LSA process is in continuous evolution, the necessity of an LSA/LSAR enhancement plan has risen within DOD. The goals of this plan, as Crabtree and Atkinson outline, are "education and training; coordination and communication; implementing Computer-aided Acquisition and Logistics Support (CALS) objectives; and LSA process enhancements" (10:17).

If the first objective has been already discussed in this review and the second one is essentially an internal need of the DOD services and American industry to share experience and obtain feedbacks during the LSA application, the other two objectives are particularly interesting and strongly interrelated.

CALS is trying "to integrate and improve design, manufacturing and logistics functions through the efficient application of computer technology" (10:18), tying together many of the current independent logistics and engineering data bases in order to allow a single terminal to have access to multiple sources of information (5:5). The enhancement plan is studying the requisites for the LSA process to be fully compatible with CALS and exploring the physical automation alternatives for accessing and exporting the Joint Service (JS) LSAR software. The LSA process enhancements provide for the transformation of the current software into a relational data base management system configuration: the revision of MIL-STD-1388-2A will reflect the CALS philosophy replacing the sequential file format for the LSAR master files with LSAR relational tables (10:19).

Barriers to ILS

One of the main difficulties for a full implementation of ILS in the USAF aeronautical system acquisition process is generally attributed to the different perspectives of the two major participants: the Aeronautical Systems Division (ASD) of the AFSC and the Acquisition Logistics Division (ALD) of the AFLC.

This issue, directly related to the organizational problems already presented in this chapter, has been the subject of a research conducted by Hull and Lockhart in 1982 (29).

The researchers, after an extensive literature review on the many potential barriers to ILS in aeronautical systems acquisition, identified eight categories, within which most of the barriers could be grouped, and developed a strategy to determine whether or not these barriers were equally perceived by the ASD program managers and the ALD logistics managers. The study was conducted at the System Program Office (SPO) level, where these problems are experienced on a day-to-day basis.

The eight factors under consideration were the following.

1. Organizational Structure: dual chain of command for the logistics manager and his importance in the SPO.
2. Deputy Program Manager for Logistics (DPML) Authority: the relationship of the ILS manager with the program manager and his lack of decision-making authority.
3. Logistics Management Tools: the actual use of LCC models, LSA, and information from previous lessons learned since the beginning of the acquisition process.
4. Logistics Skills: failure to employ well trained logisticians in the different phases of the acquisition process.
5. Working Relations: lack of establishment of a cohesive group within the SPO between logisticians and design engineers.
6. Logistics Design Goal Definition: difficulty in quantifying the reliability, maintainability, and availability parameters that should be designed into the systems and achieved by the contractor.
7. Test and Evaluation: inadequate consideration of supportability test and evaluation because of poor planning and limited budgeting.

8. Goal Conflict: despite the great emphasis given to ILS, the old priorities of costs, schedule, and performance overwhelm support considerations, leaving logistics out of the competition for the resources in a limited funding environment.

The researchers gathered data using the survey instrument and performed statistical analyses to verify the perceptions of the selected barriers inter and intra the two organizations. Finally, a rank order classification of the eight factors was attempted.

The results were:

- general agreement between ASD and ALD managers was found on almost all the barriers;
- uniform significance of the barriers was noted both within the ASD and the ALD;
- both groups recognized that the barriers had different impact and identified in the logistics design goal definition, the goal conflict, and the logistics skills the three fundamental barriers to fully implementing ILS in system acquisition.

The fact that all these three main barriers have already been discussed in this chapter among the main areas of interest in the ILS implementation, as outlined by the review of logistics periodicals, is a clear confirmation of their significance.

Although the imminent merger of AFSC and AFLC is expected to play an important role in reducing some of the current problems within the SPO, it is very unlikely that the main barriers will be actually affected.

In spite of the fact that all the considerations are focused on the particular environment of the USAF aeronautical systems acquisition, the same problems can be clearly identified in the IAF aeronautical system acquisition.

Tailoring of LSA Tasks

One of the most common problems in the application of LSA is the lack of adequate tailoring of MIL-STD-1388-1A tasks and subtasks for contracts. The result is an expensive waste of effort with subsequent overproduction of documentation, which makes more difficult the correct identification and effective use of the needed recommendations (18:4.1).

Written Guidance. The first tool is the MIL-STD-1388-1A which, in its Appendix A, provides a matrix relating the different tasks and subtasks to the different phases of the acquisition process and identifies the data item descriptions produced by the single LSA tasks. The task suitability to the specific phase is coded as selectively applicable, generally applicable, not applicable, or generally applicable to design changes only (21).

Analogous guidance is provided by the Air Force LSA Primer, AFLC Pamphlet 800-17, which, in its appendix section dedicated to the tailoring guides (12:73-87), presents in clear tables:

- the index of LSA tasks/subtasks with relative influence on system equipment design, support system design, and logistics requirements determination;
- the LSA task application and documentation matrices;
- the LSA information requirements for major systems and milestones.

Further information is contained in the AFLC LSA User Guide, which identifies the aspects of the acquisition program influencing LSA application. In addition to the specific acquisition phase, the guide briefly discusses the importance of acquisition strategy, integration of subcontractors, program funding, types of acquisition program, constraints imposed on the contractor, tasks previously accomplished, and data requirements (18:4.1). The conclusive recommendation is that:

> the program office should be able to select the tasks/subtasks that are applicable to the particular program, tailor the Statement of Work (SOW) so that only the required actions will be done, determine a proper schedule to assure all required actions are completed, and through the LSA and the LSAR tailoring process, collect and time the delivery data to best allocate the resources in meeting the goals of the program. (18:4.5)

Computer-based Guidance. Despite of their unquestionable usefulness, all these documents provide only a theoretical guidance to the task tailoring process.

Logisticians responsible for the selection of the tasks to be inserted in the contracts sometimes do not know whether or not a task is applicable and therefore tend to apply those tasks they do not understand (38:34-35).

A computer-based decision support system (DSS) for tailoring LSA tasks is a helpful alternative that can increase both the efficiency and the effectiveness of the LSA process, in a semistructured environment where the existing sufficient structure for computer and analytical aids can support the manager's judgement and decision (9:700-702).

The development of a computer-based guidance for tailoring LSA contract requirements is the subject of three recent MS theses of the AFIT School of Systems and Logistics: the first research is the basis for a computer application, whereas the other two studies are actual computer programs.

In his thesis of 1985 (38), Capt Pierce developed a set of worksheets based on a series of questions that, when answered by the user, provided an initial iteration of a tailored LSA program. All LSA tasks and subtasks were initially included, but, through a step-by-step process, driven by the answers to the given questions, the not-applicable tasks and subtasks were eliminated. To validate his worksheets, Capt Pierce formed a group of three experts from AFALC who, refining the decision rules of his logic and jointly answering the proposed questions for an acquisition trial case, created a standard against which to compare the tailoring efforts of eight ILS managers who worked individually on the same trial case (38:20-22). The results of this research indicated that the LSA task tailoring was improved with the introduction of Capt Pierce's questionnaire, although "the tailoring worksheets provided little information regarding the reasons for task inclusion, and the benefits and uses of the task" (28:15).

Capt Pierce's study was not implemented on computer, although being ready for the creation of a user-friendly automated and elementary expert system, but it was reconsidered in 1988 by Capt Dunbar, who developed a computer program to help logisticians produce "a good first-cut of tailored MIL-STD-1388-1A requirements" (23:4). The researcher chose DBase III Plus as the programming language that best could meet the conditions of a menu driven program easy to use, designed for the inclusion of narratives on LSA tasks/subtasks and LSA lessons learned, and able to provide both hard copy and computer file output of all selected LSA tasks (23:18). With the help of three LSA experts, Capt Dunbar reviewed his program in its initial and final versions in order to find a sufficient justification to make the program available and useful within AFALC. Personal discussions and informal meetings, held with ALD personnel during the preparation of this thesis, have confirmed the current use of Capt Dunbar's program both as a training tool for unexperienced logisticians and an aid in LSA tailoring.

The last thesis on this subject was written in 1989 by Capt Heffner (28), who continued the previous two studies, especially working on Capt Dunbar's research and using the same program language. Capt Heffner expanded Capt Dunbar's DSS requirements, adding the interrelationships between LSA tasks and other system engineering tasks, and the identification of contractor-performed tasks and government-performed tasks. In addition, this more complex DSS presented information on how and when tasks should be performed, what input data was required, and what output data was expected (28:30). The structure of this DSS consisted of six major modules: 1) general overview of DSS, LSA, and system engineering; 2) review of MIL-STD-1388-1A LSA tasks and subtasks; 3) LSA task tailoring; 4) LSA review and update for the specific acquisition program; 5) screen view or print of selected LSA tasks; 6) LSA lessons learned. Furthermore, a set of common modules, accessible from previous major modules 2), 3), and 4), was dedicated to LSA tailoring questions, LSA task description, LSA task application guidance, and LSA developmental supportability engineering (DSE) guidance. Also in this case, expert comments were introduced in the final version of the program and the results were fully satisfactory. Capt Heffner's DSS is useful both as a training device and as a tool for developing LSA programs.

All the three theses summarized above reach the conclusion that further research in the area of LSA decision support system is recommended. On the other hand, it is necessary to mention that new tools are under development in the field of the expert systems, that is those fully computerized systems "designed to simulate the behavior of human experts in problem solving situations" (23:3).

The US Army is developing the Logistics Planning and Requirements Simplification (LOGPARS) System (23:13) to plan and tailor all ILS requirements in order to produce the contractual documentation, whereas the US Air Force is developing the Computer Aided Tailoring Software Program (CATSP) "to tailor reliability, maintainability, and LSA requirements for acquisition efforts" (23:14).

These complex and ambitious projects testify the growing possibility of computer-based systems in the broader area of ILS and system engineering.

III. Situational Analysis

Introduction

Before proceeding in the study and discussion of the major topics presented in the literature review, a brief description of the EFA project is needed in order to explain the peculiarity of the international agreements reached by the participating nations.

It is also necessary to mention the major international and industrial similarities between the EFA and the TORNADO program. The latter will be analyzed later in the study from a logistics perspective in order to outline how the EFA program should build on the TORNADO traditional logistics experience and avoid the TORNADO support deficiencies following the ILS approach.

Characteristics of the EFA Project

Historical Background. The EFA project was a troubled international agreement since the beginning. In 1980 UK, France (FR), and GE joined a collaborative project for the proposal of a European Combat Aircraft (ECA). The project stopped before starting because of a lack of agreement between the nations, but the idea remained: an Agile Combat Aircraft (ACA) concept was developed with funds of UK, GE, and IT and an ACA full-scale mock-up was presented at the Fairnborough (UK) Air Show in 1982 (39:1, 40:32).

In the same year UK announced its intention to share with British Aerospace (BAe) the funding of a flying technology demonstrator aircraft, called Experimental Aircraft Programme (EAP), expecting that GE and IT would join the program. This never happened, but Messerschmitt-Bolkow-Blohm (MBB) and Aeritalia (AIT) participated in the EAP through private arrangements (40:33).

To clarify this uncertain situation, the Chiefs of Air Staff of UK, GE, IT, FR, and SP ratified in December 1983 the overall European Staff Target (EST) for the European Fighter Aircraft (EFA) to be produced in the mid-1990s. After the leaving of France in 1985, the Chiefs of Air Staff of UK, GE, IT and SP signed a first specification that became a more detailed agreement in September 1987 with the issue of the European Staff Requirement Development (ESR-D) document. In November 1988 industry and the nations agreed on a Weapon System Design and Performance Specification (WSDPS) and signed the Main Development Contracts for EFA under fixed-price regulations (39:1, 40:37).

Management of the Program. From the contractor side the program is managed by two consortia: Eurofighter and Eurojet. Eurofighter, representing BAe, MBB, AIT, and Construcciones Aeronauticas of Spain (CASA), is responsible for the development of the aircraft and for the integration of the engine into the weapon system; Eurojet, representing Rolls Royce, MTU, Fiat, and SENER, is responsible for the development of EFA's EJ200 engine.

From the customer side the nations are contractually represented by the NATO European Fighter Development, Production and Logistics Management Agency (NEFMA) that is responsible, as its name states, for all the aspects of the design, development and procurement (36:3).

Aircraft Description.

> The EFA is a single seat, twin engined, delta winged aircraft with the design optimized for its primary role of Air Defence, but capable of a secondary role of Ground Attack. It will be operated from Hardened Aircraft Shelters (HAS) in both peace and war; however, its Short Take-Off Landing (STOL) performance will enable it to operate from Forward Operating Bases (FOBs) and emergency runways... The design includes the extensive use of carbon fibre, aluminum-lithium alloys and super-plastic forming to reduce all-up-weight; multiple digital data buses to integrate individual systems with advanced monitoring and control facilities in the cockpit; Fly-by-Wire control system to enable the performance benefits of an aerodynamically unstable configuration to be realized; and stealth techniques to minimize radar signature. (35:1)

The aircraft will have a basic mass of 9.75 tons, a sea-land static thrust per engine of 90 kN and a gross wing area of 50 square meters (39:1).

Workshare. The industrial workshare of the program has to follow the agreed national funding of the participating nations, that is 33% UK, 33% GE, 21% IT, and 13% SP. The main partner companies are responsible for the development and production of systems under their System Design Responsibility (SDR) areas. Moreover, for the production of the weapon system, the agreed workshare assigns the front fuselage and half of the right wing to BAe, the center fuselage and the fin to MBB, the left hand wing and half of the rear fuselage to AIT, the remaining halves of the right wing and the rear fuselage to CASA (39:2).

The EFA Logistics Support Concept

All information provided in this section, limited in sources and details for classification reasons, comes from the EFA Logistics Support Concept document (35) and the logistics part of the EFA Weapon System Design and Performance Specification (25). Mention of the sources is repeated only for direct quotation or numeric data.

Support Requirements. EFA requirements and contracts specify that the aircraft shall "show significant improvements in availability, mission effectiveness and operating costs in comparison with previous combat aircraft" (35:2). To obtain this goal, the nations have developed a logistics support concept that "minimizes Life Cycle Costs (LCCs) over an in-service life of 25 years/6000 flying hours per aircraft" (35:2).

The first aim of the air forces is the achievement of self-sufficiency in support at the logistics support date, where it is practicable.

A logistics support program plan, covering all logistics activities and related milestones, has been integrated into the development contracts and will be included in the production and in-service support contracts. It covers the following support elements: reliability, maintainability, and testability (RM & T) interface with design, maintenance policy, material support, technical publications, aerospace ground equipment, personnel and training, training aids and simulators, facilities, and automatic data processing.

Within this concept, high priority will be given "to maximize international commonality throughout the logistics support element" (25:9), making use as much as possible of "existing and common resources" (25:9). The LSA will be the basis for the determination of the maintenance tasks for the aircraft, its systems and equipments.

Short description of the maintenance concept, the supply support concept, and the flexible phased-support option follow.

<u>Maintenance Concept</u>.

The maintenance concept takes the following requirements into account:

a. Maintenance requirements will be determined by a Reliability Centred Maintenance (RCM) programme.
b. All scheduled maintenance actions will be subject to full engineering justification.
c. The minimum scheduled servicing interval will be 400 FH or 24 months.
d. Periodic inspection or sampling of a structural significant item will be at least 1200 FH at LSD with a design aim of 2000 FH periodicity.
e. On-aircraft maintenance to levels 1 and 2 will be carried out by base personnel. It will be possible to carry out level 1 and limited level 2 maintenance on deployed sites.
f. Off-aircraft maintenance activities will initially be allotted to the air force or industry as a result of the LSA process and the subsequent customer/industry evaluation. Level 2 repair facilities will be set up in the air forces when identified as cost effective by LSA and when design stability and customer capability permits.
g. Except otherwise specified, all components will have a service life of 6000 FH. (25:11)

Both on-aircraft and off-aircraft maintenance will be improved by the satisfaction of the contractual RM & T requirements and by the built-in-test capability for defect diagnosis.

Specifically, the contractor shall demonstrate compliance with: 1) a failure rate of 400 failures/1000 FH; 2) a total direct maintenance manhours per flying hour not exceeding 9 MMH/FH, 3 years after the logistics support date; 3) on-aircraft recovery times of 45 minutes for 50% of defects and 3 hours for 95% of defects; 4) off-aircraft recovery times of 105 minutes for 50% of defects; 5) 100% detection of predetermined failures and 90%, 95%, and 99% location of predetermined failures to 1 module, 2 modules, and 3 modules, respectively (25:4-8, 39:3). To compare these requirements with other programs' requirements, it is necessary to specify what failure and defect mean in the EFA contract documents. As defined in the EFA logistics glossary of terms, "failure of an equipment is any defect of that equipment which creates an inability of the previously acceptable equipment to perform its required function within the limits established in the contractual specification" (24:B.4), whereas "defect is any primary malfunction in a system, subsystem, equipment or component which requires a correction by unscheduled maintenance work" (24:B.3).

"The transfer of maintenance responsibilities to the air forces will be a gradual process" (35:B.7) that will be carried out in three phases to be completed within approximately 5 years from the logistics support date.

Supply Support Concept. The supply support concept for EFA will cover initial procurement as well as in-service support under quadrinational plans that have to identify related activities and timescales.

The Logistics Support Date (LSD), conventionally fixed at 31 December 1996, is the overall target for the activities of initial provisioning, but, to achieve availability of spares by that date, the parts shall be ordered with adequate lead time. In broad terms, "line replaceable items will be ordered 3 years prior to LSD, modules or repair spares will be ordered 18 months prior to LSD and piece part spares will be ordered 12 months prior to LSD" (35:C.10). Because of the unstable aircraft design at the placement of the first orders, the "initial provisioning orders will be related to a particular batch standard and a contractual facility provided to allow the actual part number on order to be varied on the approval of a change in aircraft standard" (35:C.2). The weapon system should reach the figure of 620,000 parts with about 150,000 different part numbers. The identification and ordering of these items in the selected quantities will start in 1992 and should end in 1999 (26:26-29).

Nations will use new procurement software and procedures for both initial provisioning and order administration functions, capitalizing the investment for the automated data processing (ADP) system under development for the TORNADO long-term in-service support. National ADP systems must interface with this procurement system using the procedure of the European AECMA 2000 standard (26:29).

The Flexible Phased Support Option. The achievement of self-sufficiency by the LSD through the correct support resources is one of the major aims that nations are trying to obtain with the ILS/LSA program. However, because of the instability of some of the more complex designs and the non-availability of sufficient information to take firm decision, nations have contractually imposed on industry the possibility to postpone the acquisition of the support of certain equipment.

> Phase Support (PS) is defined as those special activities performed by suppliers during the transitional period immediately following entry into service, during which nations develop their steady state support capabilities. The concept of PS is an integral part of the ILS strategy and is designed to ensure that suppliers properly incorporate supportability in the design of their equipment. Whilst all on-aircraft work will be undertaken either by the service or industry personnel, selected suppliers are also required to share support risks and provide option prices for the off-aircraft support of their own equipment. Such quotation, submitted as part of the overall tenders to supply the equipment, if taken up by the nations, form the basis of PS. Following the PS contract period, support responsibility may be transferred in a timely and controlled manner, item by item, until such time as the required level of support capability is reached by each of the customer air forces. (36:9)

Potential candidates for phased support will primarily be identified from data obtained from the LSA records.

Among the advantages that nations expect from this option there are the following: provisioning based on better evidence; Aerospace Ground Equipment (AGE) and test equipment based on improved data; postponement of decision on third level maintenance facilities; reduction of initial training requirement.

International and Industrial Similarities with the TORNADO Program

The Italian Air Force (IAF) has gained experience in the logistics management of international cooperative programs with the MRCA (Multi-Roles Combat Aircraft), better known as TORNADO, "a two-engined, two-seated supersonic fighter equipped with a variable-geometry wing ... (and) ... powered by the RB.199 turbofan" (41:202). This aircraft was designed between the end of the sixties and the beginning of the seventies, and was produced from 1974 onwards in more than 800 units delivered to Great Britain (47.5%), Germany (40%), and Italy (12.5%) (41:202). These figures do not take into consideration the air defense variant (ADV) for UK only, the electronic combat reconnaissance (ECR) version for GE and IT, and the export sales to Oman, Saudi Arabia (7:157) and Kuwait.

With the exception of Spain, the TORNADO program grew in the same industrial environment of the EFA program: the EFA Eurofighter and Eurojet consortia are only the needed broadening of PANAVIA (BAe 42.5%, MBB 42.5% and AIT 15%) and

Turbo-Union (RR 40%, MTU 40% and FIAT 20%) consortia, responsible for the weapon system and the RB.199 engine, respectively (41:164). Also the NATO management agency for EFA, NEFMA, was established in the likeness of NAMMA (NATO MRCA Management Agency), but, as a result of the previous experience, with "a NATO charter which fully embraced logistic matters" (34:A.1). The main logistics lesson learned from the TORNADO project was, in fact, the insufficient impact on design for supportability with following inadequate time and very high costs to provide the necessary level of support (34:A.1).

The logistics results of the TORNADO program are, in essence, the same reasons that gave rise in the USA to the development and implementation of the ILS methodology, as explained at the beginning of Chapter II. The logistics lessons learned from the TORNADO, discussed daily within NEFMA, industry, and the nations in order not to repeat similar mistakes in the EFA program, will be analyzed under the section dedicated to the findings of the thesis together with the results of the study of the ILS American experience.

IV. The Study of the USAF Experience

The USAF Lessons Learned Data Base

The Program. The USAF Lessons Learned Program, recording and sharing past logistics experiences, provides a valuable contribution to the Acquisition Logistics Division (ALD) goal of bridging "the gap between the acquisition and logistics communities" (2:i) and improving "reliability and supportability of new weapon systems coming into the Air Force inventory" (2:i), while reducing the total life cycle costs of these systems.

The objective of the program is to gather, validate, store and disseminate lessons that can be of value in the conduct of present and future programs or modifications. Talks with ALD personnel have outlined the continuous progress of the program which started manually in 1977, was automated in 1978, and became on-line accessible in 1988. Currently, more than 2,500 lessons are contained in the data base, covering both management and technical experiences.

> Management lessons address program decisions and actions in such areas as program control, budget/financial control, contracting techniques, support planning, configuration management, maintenance concepts and data management.
> Technical lessons relate to systems, equipment and components, including hardware, software, support equipment, or the design factors that influence the performance of the system or equipment. (2:i)

The following two tables provide the full list of the areas covered by the data base, as presented in the most recent hard copy lessons learned abstract (2).

TABLE 1

LESSONS LEARNED DATA BASE LOGISTICS ELEMENTS

Computer resources	Reliability and Maintainability
Energy Management	Safety
Engineering Data	Supply Support
Facilities	Support Equipment
Funding	Survivability
Logistics Management Information Support	Technical Orders
Maintainability	Test and Evaluation
Maintenance Concept	Transportation, Packaging and Handling
Modification Planning	Training and Training Support
Manpower Requirements and Personnel	Artificial Intelligence
Reliability	Propulsion System

Source: Air Force Logistics Command. "Air Force Lessons Learned Program." Abstract, 6th Edition. Acquisition Logistics Division, Wright-Patterson AFB OH, October 1989 (2:iii).

TABLE 2

LESSONS LEARNED DATA BASE MANAGEMENT ELEMENTS

Configuration Management	Operational Requirements
Contract Administration	Program Control
Contracting	Quality Assurance
Data Management	Source Selection
Engineering	Program Management Responsibility Transfer
Foreign Military Sales	Logistics Support Analysis
Human Factors Engineering	Program Management
Life Cycle Cost	Environmental Management
Manufacturing	Warranties.

Source: Air Force Logistics Command. "Air Force Lessons Learned Program." Abstract, 6th Edition. Acquisition Logistics Division, Wright-Patterson AFB OH, October 1989 (2:iii).

The single lesson, normally one page in length written in easily understood terminology, is submitted to ALD experts in accordance with a form that requires the identification of the topic, the statement of the single most important finding, the description of the problem experienced, the discussion of the findings in relation to the specific situation, procedure, or design, and, finally, the recommended action. The following validation and introduction into the data base allow the immediate use of the new lesson by the personnel of the government agencies and contractors engaged in military business. The lessons learned cycle is completed only through the user feedback that is the main instrument for maintaining the data base up-to-date, with changes and removals of existing lessons.

The data base already contains contributions from the Navy and the Army, but, among the ALD initiatives, a joint services program is the first aim. Promotional programs and software improvements should enhance the collection of new inputs and the use of the system that, during 1990, received about 300 requests a month.

The Research in the Data Base. After a first reading of the abstracts of the lessons in the specific areas of interest, such as reliability, maintainability, configuration management, contracting, and LCC, full research was conducted in the data base focusing on problems and actions related to the LSA implementation. The management lessons mentioned in this section are referred to by their call number for an immediate retrieval from the data base.

The general comment concerning the LSA problems documented in the data base is that the customer frequently fails to apply the basic concepts on which the LSA approach is founded. MIL-STD-1388-1A and -2A are often mechanically applied, without the necessary tailoring and the required continuous refinement (3:1373), which is the cornerstone of every iterative process. Furthermore, the LSA is sometimes performed at the wrong time (3:1158), with the result that the main function of influencing the design is lost and the analysis is reduced to the production of documentation of limited value. This kind of LSA only nominally is the tool of a logistics support that, consequently, fails its integration function among the logistics elements. Lack of compatibility between ADP systems (3:1736), poor quality of LSA/LSAR data (3:1442), and equivocal or erroneous contractual formulation (3:0944) are only typical issues that should be taken into consideration by the IAF officers who perform activities similar to the SPO's logistics functions.

The Status of the LSA Process in the USAF Programs

The LSA Acquisition Review Group Study. Concerned about the application of the process within the USAF, Lieutenant General Leo Marquez, Air Force Deputy Chief of Staff for Logistics and Engineering, directed a study of the LSA process in 1986, in order to evaluate the situation and make recommendations for improvements. An LSA Acquisition Review Group of 25 people was formed from Headquarters (HQ) USAF, Air Force Systems Command (AFSC), Air Force Logistics Command (AFLC), Strategic Air Command (SAC), Military Airlift Command (MAC), Air Training Command (ATC), Air Force Communications Command (AFCC), Tactical Air Command (TAC), Air Force Space Command (AFSPACECOM), and Air Force Operational Test and Evaluation Center (AFOTEC) (14:i, 17:36-37) "to make an in-depth study of the Air Force LSA/LSAR process as it impacts (the) ability to field supported weapon systems" (17:4), reviewing all activities of the full life cycle from design, development and production to post-production support.

The team was organized in four panels responsible for Policy, Program Application, Education & Training, and Data Systems & Software Management. Each panel, after a thorough documentation review to establish a base line for LSA in the respective area, developed questions to determine the current status of LSA in that specific area.

> The questions were combined into a general questionnaire, intended for all respondents, but the questionnaire also included special sections intended for only contractors, or only developers, supporters or users. The questionnaire included true-false, multiple choice, and narrative answer questions. (14:3)

The full questionnaire is shown in Appendix C.

The data collection phase was accomplished by the team members through visits to selected Air Force and contractor sites. Structured interviews with "the most knowledgeable person, regarding LSA, on a given program" (14:3) were conducted and in few days more than 140 valid questionnaires were filled (14:3).

Data analysis was performed with the help of a large computer spreadsheet (Lotus 1-2-3) where the data collected from the questionnaire were loaded. With this tool, the over 10,000 answers could be extracted in a number of different ways, allowing investigation of various scenarios and areas of interest. The objective answers to the true-false and multiple choice questions were statistically tabulated, whereas the narrative answers were evaluated on a subjective basis.

Four different analyses were performed with the purpose of clarifying doubts and beliefs in specific areas of interest (14:4-5, 16:23-24). The first analysis evaluated the data from the various perspective of the respondents, who were divided into the four categories of developers, contractors, supporters, and users. The second analysis investigated in which acquisition phase LSA was first applied to the program, to verify whether an earlier application of LSA improve the design and increase supportability. The third analysis evaluated the data based on the current acquisition phase of the program, to monitor how things are viewed over time, and check whether problems really do not surface until the production/development phase. The forth analysis assessed the changes in performance of LSA created by different versions of LSA applied to contracts over time, to verify whether the earlier versions without programmatic tailoring be less effective than the later versions of LSA.

<u>The Study Observations</u>. The detailed data analysis described above led to 11 general observations: four related to policy (observations #1, #2, #3, #4), one to education and training (observation #5), one to resources (observation #6), three to program application (observations #7, #8, #9),

and two to data systems and software management (observations #10, #11). They are briefly summarized in sequential order, with heavy use of citation from the Study Report (14) and the Action Plan (15) of the LSA Acquisition Review Group Final Report issued in March 1987.

Observation #1 (14:9-12, 15:2-13): "Current directives place insufficient emphasis on how to do early Air Force analysis to impact system design" (14:9). The major findings on which this statement is based were the existing policy requirement for beginning LSA with the concept exploration phase, the lack of specific guidance on how to conduct an early LSA, and the current LSA policy oriented to logisticians and not designers. The recommendations were to "develop an Air Force annex to MIL-STD-1388-1A to tie LSA tasks to engineering analysis tasks" and "incorporate LSA requirement into system requirement documents, detailing LSA tasks in appropriate military specifications and standards" (14:iv).

Observation #2 (14:13-15, 15:14-23): "Existing directives do not adequately address the application of LSA to mission critical computer resources (MCCR) software or information system program acquisition" (14:iv). The study revealed that few software programs effectively use the LSA/LSAR process although LSA guidance specifies LSA application to both hardware and software. The recommendations suggest the inclusion of LSA/LSAR requirements in the appropriate system acquisition directives and "the harmonization and linking of LSA, LSAR and software military standards" (14:iv).

Observation #3 (14:16-17, 15:24-64): "Engineering directives do not integrate LSA and LSAR with engineering tasks" (14:16). The result is that supportability requirements and constraints are not considered during early system design. The action recommended is "the incorporation of the LSA process and LSAR into the appropriate engineering handbooks, standards, and directives" (14:iv).

Observation #4 (14:17-20, 15:65-83): "Although LSA and the LSAR apply to a system/equipment throughout its life cycle, current policy focuses on acquisition phases only" (14:17). The study found that the directives governing modifications and material management do not require or recognize the LSA/LSAR process and it recommended the appropriate changes to the regulatory guidance in these specific issues.

Observation #5 (14:20-24, 15:85-90): "Lack of education and training in LSA, particularly for engineers, weakens effectiveness of LSA and increases impact of personnel shortfalls and turnover" (14:20). The findings were that no formal Air Force course is specifically dedicated to LSA, the Air Force Institute of Technology (AFIT) includes LSA only in few courses in the School of Systems and Logistics and in no course of the engineering studies, and the US Army course has limited value to the Air Force. In the short term it is recommended to continue with informal workshops and local courses already in existence to reduce training short falls, whereas, for the long term, "an Instructional System Development program ... should be performed to systematically identify and address total Air Force LSA education and training needs" (14:v).

Observation #6 (14:25-26, 15:92-93): "LSA and the LSAR review process are manpower intensive; sufficient qualified Air Force people are not available" (14:25). The study recommended to "expand availability of LSA education and training" and "develop a state-of-the-art LSA data system to reduce the manpower intensiveness of LSA utilization" (14:26).

Observation #7 (14:27-31, 15:95-97): "The impact of LSA on system design is hit and miss" (14:27). The study revealed inadequate tailoring of LSA to specific programs and incorrect contract placement of LSA requirements. It recommended "integration of LSA into systems engineering by making that integration the engineer's responsibility" (14:vi).

Observation #8 (14:31-33, 15:98-100): "Duplicate data are being acquired and available data are being used inefficiently" (14:31). The findings were that LSAR data to support other functions such as failure modes and effect criticality analysis (FMECA) are being bought twice and LSAR outputs may not efficiently satisfy contract data requirement list (CDRL) requirements. The team recommended the elimination of data duplication and the improvement of "the capability to manipulate LSAR output products to better meet CDRL requirements" (14,vi).

Observation #9 (14:33-35, 15:101-102): "LSA and the LSAR process are not continued throughout system life" (14:33). The study outlined directives conflict on the LSA application to modifications, ineffective LSA application to warranties and no procedures for continuation of LSA after Program Management Responsibility Transfer (PMRT). Guidance changing and performing supportability analysis on warranted items were the recommendations.

Observation #10 (14:36-37, 15:104-105): "The current Joint Service standard LSAR ADP system is a batch system which does not meet today's requirements for an on-line automated system. Consequently contractors develop their own automated LSA systems" (14:36). The team found a number of different systems in use that do not allow automated transfer of data among program participants and it recommended the establishment of an enhanced standard automated LSA system.

Observation #11 (14:37-39, 15:106-107): "The interface/integration between data created as a result of the LSA process and data required for AFLC data systems and other Air Force program is not being adequately addressed" (14:37). The findings were that a number of data elements are common to the LSAR and other data bases and manual transfer among these data bases is currently required. The recommended solution was that appropriate LSA data should be taken directly from the LSAR data base for input to other data bases through automated capability.

<u>The Study Conclusions</u>. The results of the survey conducted by the LSA Acquisition Review Group drew six major conclusions which fully confirmed the deep concerns at the origin of the study. The final recommendations of the team was the strong request of top-level Air Force commitment to the effective application of LSA (14:42).

The six major conclusions mentioned above are briefly discussed in the following part of this section.

"LSA should be included in requirements determination" (14:40). The theoretical influence of support requirements on operating concept and design can be achieved only with the application of certain LSA tasks already in the pre-concept and concept exploration phases.

"The Air Force must expand the scope of supportability analysis and get more using command involvement in the process" (14:40). Appropriate tailoring of LSA tasks is the cornerstone for a correct evaluation of concept and design alternatives.

"For LSA to have a stronger impact on system design, its integration into system engineering should be made the responsibility of the engineering community" (14:40). If supportability is not considered by design engineers, LSA only documents how to support the designed system.

"LSA should be continued throughout a weapon system's entire life" (14:40). LSA could be useful in the identification of requirements for modifications and the evaluation of support system alternatives.

"The application of LSA and the LSA Record to acquisition of mission critical computer resource (MCCR) software and information systems is needed to ensure that system supportability is considered" (14:vii). Software logistics is a new element that must be covered by the LSA process even if current directives do not call for LSA.

"To improve Air Force capability to effectively employ LSA and get the most benefit from the LSAR, improvement in education and training of Air Force personnel and the tools used in analysis and data manipulation are necessary" (14:40). An LSA data base able to interface with data bases of other information systems is essential for efficient data transfer among systems.

The findings of the LSA Acquisition Review Group study cover, once again, all the main issues outlined in the literature review of Chapter II. They support the firm belief that the reasons for low effectiveness in the LSA implementation, and more generally in the ILS methodology, are well known and clearly identified. The more reasonable way to start in solving these problems is the commitment to fully apply the ILS/LSA principle in the newest weapon system acquisition programs.

The next part is dedicated to the logistics approach in the Advanced Tactical Fighter (ATF) program, where the basis for better logistics results has been established from the beginning of the acquisition process through the definition of global weapon system requirements.

The ATF Experience

The Program. The Advanced Tactical Fighter (ATF) is the new air-superiority fighter that will be fielded at the beginning of next century. It will be characterized by high degree of self-sufficiency and improved supportability, in order to achieve remarkable combat sortie rates (4:1).

> The ATF program manages both prime airframe and engine contractor efforts. Demonstration/Validation contracts were awarded to competing airframe contractors, Lockheed and Northrop, on 31 Oct 86 for a 50 month effort. Basic Demonstration/Validation contracts were awarded to competing engine contractors, General Electric and Pratt & Whitney, on Sep 83 with a prototype modification being awarded Dec 87 for an effort extending to Dec 91. ... Each airframe contractor is to build two technology demonstration prototype aircraft and one ground-based avionics demonstration laboratory. Each engine contractor will provide a set of engines to each airframe contractor. First flight of the ATF prototype aircraft occurred during the forth quarter of FY90. (4:1)

At the end of April 1991, the selection process indicated the Lockheed team - Lockheed, General Dynamics and Boeing - as the winner. Lockheed will be responsible for forward fuselage and cockpit, part of avionics, weapon systems integration, and final assembly; General Dynamics for middle fuselage, tail, landing gear, and armaments; Boeing for wings, rear fuselage, part of avionics, engine installation, exhaust nozzles, and training system (42:4F).

The Support Concept. From the logistics perspective, the Air Force requirements can be summarized with the following goals: reduced mobility requirements, elimination of avionics intermediate shop, high reliability, line replaceable avionics modules, maximum use of integrated diagnostics, minimum support equipment, and reduced manpower (4:2). Particularly interesting is the quantification of the mobility requirements: it has been contractually imposed on industries that the weapon system shall be supported by not more than eight C-141 aircraft for a 30-day deployment of a 24-aircraft squadron (30).

The ATF program is aiming at the full integration of logistics and engineering functions. It is being developed under the basic concept of an Integrated Product Development and Concurrent Engineering: both industries and Air Force have established Integrated Product Teams where logisticians are working day-by-day with engineers (30).

The weapon system has been designed as a single entity consisting of three separate systems that cannot proceed singularly because contractually linked: the Air Vehicle System, the Support System, and the Training System. All the activities are managed following an Integrated Master Plan (30).

Until the current phase, i.e. the end of the Demonstration/Validation phase, "the contractors are responding exceptionally well in treating support as co-equal to performance, cost and schedule" (4:3), giving maximum priority to the reliability and maintainability requirements (4:4).

The ILS elements, although being developed as a whole, will not be managed as a global activity because each maintenance activation function "will be done for each aircraft subsystem as an entity by the activation working group. This will then be provided to the base and/or depot as a fielded maintenance capability" (4:4).

Probably the most advanced objective of the ATF System Program Office (SPO) is the firm intention "to acquire, field and support the ATF weapon system in a nearly paperless environment" (4:5). It is under development an advanced computer-aided system for all levels of maintenance documentation that will be available on-line from a relational Integrated Weapon System Data Base (IWSDB). Similar concept is under evaluation for the engineering data that should become accessible through the same IWSDB (4:5-6).

Logistics Aspects of the ATF Acquisition Program. An interview (30) with the Assistant Deputy Program Manager for Logistics of the ATF SPO allowed the writer to highlight some logistics aspects particularly interesting for the scope of this thesis. This section covers the topics in the order in which they were discussed.

The influence of support considerations on design has been experienced within the SPO. A Design Influence Team was established to use the contribution of logisticians in the design activities. Experienced maintenance people, above all senior noncommissioned officers, have particularly contributed to the maintainability requirements such as location of refuelling receptacle, ammunition loading station, maintenance data panel, turn-around operations to be completed in twenty minutes. The same team is, within the SPO, the major user of the lessons learned data base discussed in the first part of this chapter. They do not enter the system daily, but refer to it in case of previous similar situations or bad experience.

The SPO started to use LCC models from the beginning of the program to produce an estimation that could be used as a matter of comparison. During the demonstration/validation phase a model called Z-core has been run.

In the prototype phase, industry did not use LSA and only a preliminary LSA was performed by the SPO that considers the process more suitable for a single design than for different options of the same weapon system. In the demonstration/validation phase, both competitors have demonstrated only the capacity to perform LSA during the development phase. The contractual documents impose that the LSAR will be built with a relational data base, already in line with the MIL-STD-1388-2B, that has not yet been issued.

An Integrated Management System has been introduced by a separate program in order to achieve full accomplishment of a relational data base. On-line access to the LSA data base will be possible for all the development phase through SPO terminals that will be connected also to the Computer-

Aided Technical Systems (CATS) industrial engineering drawings, emphasizing the already discussed integration between engineering and logistics aspects. LSA reviews for the development phase are expected to be done via computer terminals, with direct access to the single LSA data base.

For the demonstration/validation phase no Decision Support System was used in tailoring the LSA tasks and the same is expected for the Full Scale Development phase. The SPO has already decided that, with the future total automated integration between the Air Force data bases, no LSAR use is expected after the development phase. Till the end of the demonstration/validation phase, no logistics consideration arrived too late to act as effective feedback for the design characteristics.

About the idea of how to obtain a satisfactory software maintenance plan, the SPO has already prepared a first draft of a Post Deployment Software Support Plan. A Software Integration Laboratory (SIL), equal to the industrial development environment, will be established at the appropriate depot at the end of the development phase.

The new Computer-aided Acquisition and Logistics Support (CALS) philosophy, briefly discussed in Chapter II, is fully in line with the contractors' proposals that will be updated to reflect the new CALS standards as soon as they become available. The already mentioned LSA relational data base, the total transmission of electronic data under military regulations, the deliverability of all product data via electronic media, the technical order data philosophy that excludes the use of hard-copy documentation, and the CATS engineering drawings are all examples of the strong CALS oriented approach. The exceptional effort in computerizing all logistics functions is clearly highlighted by the on-line quantification of initial provisioning that will be performed by the SPO through a continuous comparison between the industrial recommended quantities for each major item and the available data contained in the engineering/ logistics data base. Also support equipment will be selected, approved, and ordered through on-line computer systems that will have full access to the existing Air Force support equipment data base, containing also all the relative engineering data, current use, and availability within the Air Force.

About the organizational and authority problems within the SPO discussed in Chapter II as barriers to ILS, the Assistant DPML of the ATF SPO has confirmed that all the authority stays in the Program Manager (PM). This is particularly true today that the PM is a brigadier general and the Logistics Manager (DPML) is a lieutenant colonel, although the organization chart of the ATF SPO calls for colonels in both positions.

Despite this atypical situation, the current relationships within the ATF SPO seem to be positive and fruitful, with a PM who has driven the project following an up-front logistics planning and impact from the beginning and has already forced industry to fix some design deficiencies affecting logistics requirements, such as the one previously mentioned in relation to the Design Influence Team.

The interview has clarified that in the American acquisition programs there is no separate funding of industrial logistics activities. Until the current phase, all the program has been funded to a certain limit, leaving industries the responsibility to invest as much as possible in the prototype development. For the development phase, a cost-plus contract within fixed-threshold will govern the relationships between industry and Air Force. Large emphasis has been given to the incentive program that will allow contractor to gain, on a 6-month basis, a percentage premium if the required conditions are successfully reached or exceeded.

Because of the early stage of the program, no request of reduction in some of the original logistics requirements has been experienced. Anyway, the particular design of the weapon system, conceived as a single entity with operational, logistics and training characteristics linked together, should make more difficult to operate drastic cuts in the logistics area as soon as funding problems are experienced. Other factors such as reduced number of aircraft or time delivery seem more likely targets of reduction under limited resources constraints.

The ATF has no option similar to the EFA Phased Support presented in Chapter III. Only at depot level a contractor support is expected for a certain period, but this effort has not yet been quoted. The Air Force is very confident in the results of the expected full engineering/logistics integration that should determine an early stable configuration of the equipment. Also high reliability is given to contractors. On the other hand, the high diagnostic capability and the intrinsic reliability of the project should allow the total cancellation of the second level for avionics equipment, as already noted in the previous section.

V. Discussion

Introduction

The previous chapters, through the review of the ILS literature (Chapter II) and the study of the experience of the USAF in past and current acquisition programs (Chapter IV), have outlined a series of logistics problems that can be related to the current situation of the EFA program described in Chapter III.

The main findings of this documentary research are discussed in this chapter, presenting before the more general issues, which are universally applicable to the logistics efforts of the IAF, both in and outside the EFA program, and then specific topics, peculiar to the characteristics of the EFA project. This second part presents also a detailed analysis of the major logistics problems of the TORNADO program, which resulted primarily from the lack of a global support concept, and provides some guidelines on how to capitalize on this direct experience.

Applicability of the Experience

The Acquisition Logistics Management Organization and the Logistics Influence on Design. The USAF weapon system acquisition management is a quite complex function that is still far from optimal. Despite the objective difficulties experienced in the management of logistics functions during the early stages of the acquisition process, the USAF organization allows a single approach for the engineering and logistics functions. The existence of a System Program Office (SPO) for each program assures a centralized control of all the aspects of the project, especially from the contractual perspective, where technical and support issues should find at the same time their appropriate and combined recognition (27, 29, 30, 37).

In Italy, neither legislation nor current practice provides logistics an important role within the acquisition process. An aerospace agency of the Ministry of Defense (MOD) is responsible for all contracts with industries, whereas the air force is responsible for the support of the weapon system after its deployment. The establishment of multinational government agencies, such as NAMMA for TORNADO and NEFMA for EFA, has certainly contributed to give support aspects higher considerations in the definition and development phases of a new weapon system, but, on the other hand, it has added more complexity because of the different allocation of responsibilities in the central organizations of the different nations.

The findings of the research clearly emphasize the importance of the active role of ILS on design, but they also remind that the contractual coverage of support requirements from the early stages of the acquisition process is only a prerequisite for the success. Without the commitment of the highest managers of the IAF, logistics will never be able to influence design. The discussed linkage between engineering and logistics, that in the USAF occurs within the SPO, is also possible for the first time in the EFA program where the development contract has required the establishment of the International Air Forces Field Team (IAFFT). This multinational team consists of four elements, one based at each of the Eurofighter partner companies, tasked with monitoring and participating in all logistics aspects of the program, especially LSA (39:2-3). Unfortunately, some of the nations, and Italy too, have not fully understood the unique role of this team and have not sustained its functions as it should be necessary. Although some benefits are already lost, there is room for fruitful utilization of this resource during the development phase of the program.

<u>The Acquisition Logistics Educational Problem</u>. The need for education in logistics, and particularly in acquisition logistics, is a definite outcome of the research. The literature review has outlined that one of the major problems in effectively implementing the ILS process in the acquisition programs is the professional and technical qualification of people involved in the acquisition business and that, within the SPO, the lack of logistics skills does not allow the employment of well trained logisticians in all the different phases of the acquisition process (27, 29, 32). The same result was reached by the LSA Acquisition Review Group, specifically in relation to effectively employ LSA and get the most benefit

from LSAR. The USAF is still trying to overcome this problem through a systematic instructional system development program that, to move its first steps, needs the recognition of higher priority among the requirements of the Air Force (14).

This problem is fully shared by the IAF, which has not produced yet a global plan to bridge the gap between needs and reality. In the last few years the IAF has undertaken short term solutions such as sending personnel directly involved in logistics international projects to ILS and LSA seminars and conferences in Italy and Europe, and two-week reliability and maintainability courses at AFIT, or introducing seminars and lessons on the topic in the regular courses of the Air Force War College, specifically addressing IAF pilots and engineers who more likely than other officers are called to deal with acquisition logistics problems. Also the author's attendance in the Graduate Logistics Management Program at AFIT is a sporadic initiative that is unlikely to be repeated, although similar courses are not offered by Italian universities. The most feasible solution seems to be the inclusion of systematic discussion of the subject, at different levels, in the numerous schools of the IAF in order to create a diffuse basic knowledge in acquisition logistics.

The Logistics Automated Environment. Probably, the most evident finding of the research is the absolute need of automated systems for the management of logistics in general, and acquisition logistics programs in particular. Logistics is heavily dependent on data and the only choice for an appropriate use of the ILS approach is the continued growth of automated capabilities within the air force. The CALS (Computer-aided Acquisition and Logistics Support) effort for the integration and improvement of design, manufacturing and logistics functions through the efficient application of computer technology is already being introduced in the newest USAF weapon system acquisition programs, such as the ATF program. The establishment of relational data bases, able to communicate and exchange data each other, is the starting point for an efficient and relatively economic availability of information in a modern organization. Duplication of efforts, need for manual intervention, and useless accumulation of data are the main problems that the USAF is trying to solve, allocating to this area extremely high priority in terms of human and financial resources (30). The computerization of all logistics functions and the transmission of electronic data under military regulations will provide immediate benefits in the acquisition process, such as the continuous interface between engineering and logistics functions, the on-line quantification of initial provisioning, the creation of an updated and user-oriented documentation system, and the logistics program management in an almost paperless environment (5, 10, 14, 30).

The current efforts undertaken by NEFMA and industries to build the support of EFA in an automated environment (34) and the following problems encountered are amplified by the multinational characteristic of the program, with incompatibility of systems among air forces and industries, and the economic need to take advantage of existing computerized facilities and communications networks.

The personal experience of the author, after one year spent in the USA together with USAF personnel, has outlined the gap existing between Italy and the USA in the ADP area. The difference does not stay in technology or knowledge, but in the widely extended distribution and utilization of computer systems in any activity all over the country: market and prices are totally different. The same considerations apply to the logistics organization of the IAF, which is still experiencing difficulties in the transition to an automated environment, so that is being developed in uncoordinated way with resulting low efficiency. If automation in the engineering and material supply elements started with the TORNADO project, the acquisition logistics is entering the ADP environment with the EFA program. In the automation of this logistics field the IAF is currently dependent on national aerospace industry and still not prepared to formulate a consistent policy. Improved data collection in each logistics area and more frequent use of statistical techniques in the logistics decision making process are the other factors directly related to the use of computer systems that should receive higher attention in the IAF.

The LSA Implementation. An unexpected result of this study was to find out that the USAF, despite its effort and experience in a variety of programs from the publishing of MIL-STD-1388-1A/2A (20, 21), is pretty far from an optimal application of the LSA process. The conclusions reached by the LSA Acquisition Review Group, described in Chapter IV (14), confirmed the deep concerns that had originated in 1986 the study of the status of the LSA in the USAF programs. Failure in LSA inclusion in requirements determination, partial integration into system engineering, limited tailoring of LSA tasks to the characteristics of the program, lack of LSA application to software programs, and need of improvement in personnel education and automated systems are the main shortfalls experienced by the USAF in the implementation of LSA in the acquisition programs. Similar problems were outlined by the research in the ALD logistics lessons learned data base (2), and the military and related periodicals (10, 11, 22, 31, 33, 37).

The conclusion that can be drawn from these unanimous comments is that the reasons for low effectiveness in the LSA methodology are known and the possible solutions have been identified, but the introduction of the corrective actions is a long and difficult process.

The best means to achieve encouraging results seems to be the full commitment of all personnel involved in the acquisition process, particularly for the newest weapon systems.

As repeatedly mentioned in this thesis, the EFA program will be the first application of the LSA in the IAF. Therefore, it was extremely useful to understand the problems encountered by the USAF because the current Italian fluid situation allows the establishment of appropriate directives and procedures. Since similar situations are experienced in Italy by the Army and the Navy, a joint approach to this problem of national regulations could be fruitful within the whole MOD in order to maintain the active role that characterizes LSA. Although the EFA program is already in the full development phase, some recommendations can be included, especially in the ongoing process of interface between the national industry and the IAF that will continue until the end of the production phase. The closest activities in which the IAF can exercise its contractual power will be the LSA reviews, where the LSAR data validity must be verified to find possible discrepancies in the data and avoid delays in the LSA program schedule. Also the function of the LSAR after the production phase should be carefully evaluated by the IAF. The USAF has recently proposed not to maintain LSA records after production because their information will be already included in the data bases dedicated to the specific support elements, such as material supply (IPMIS, Initial Provisioning Management Information System), maintenance planning (DMMIS, Depot Maintenance Management Information System), and technical orders (ATOS, Automated Technical Order System) (43:1-3). Under CALS philosophy, full integration among these systems will avoid data duplication and improve data accuracy. In the next few years, on the contrary, the IAF will face serious problems in the integration of its logistics information systems and the LSAR of each program could be the core for the development of a single data base.

Finally, another major lesson learned from the research was the use of automated guidance in tailoring LSA tasks and subtasks to the specific constraints and peculiarities of the program. Although this experience comes too late for the EFA, the use of LSA tailoring computer programs will certainly be proposed by the author to the appropriate logistics managers in the IAF. Decision support systems, such as the programs designed by Capt Dunbar (23) and Capt Heffner (28), or elementary expert systems, such as the computer implementation of Capt Pierce's logic (38) prepared by the author together with another student in the Logistics Decision Support Systems course at AFIT, will be used within the IAF, both as training tools for unexperienced logisticians and aids in LSA tailoring.

Specific Findings Applicable to EFA

In addition to the general issues discussed before in this chapter, the research has outlined some specific lessons directly applicable to the EFA program. The first part of this section aims at combining the American ILS experience with the specific characteristics of the EFA program, dealing with ILS organization and manpower resources, contractual logistics incentives, and ILS standards. The last part of the section, on the contrary, is dedicated to the indications that come from the problems experienced with the TORNADO project in the different logistics areas and show the way to follow in the EFA program under the ILS approach.

ILS Organization and Manpower Resources. Probably due to the national organization of the acquisition management described at the beginning of this chapter, the IAF has not given to its ILS manager the appropriate level of individual authority and control of staff that is necessary to achieve satisfactory results, as the literature review and the study of the USAF experience have clearly outlined (29, 30, 37). In the EFA program, in fact, the air force ILS manager is the senior officer responsible for the cost-effective achievement of the support requirements and for the integration of the ILS disciplines. He has to play his role in the international context of customers and contractors (NEFMA ILS board) and in the continuous relationships with the national industries that, at the end, will be the providers of the specific functions of the IAF support.

Furthermore, the IAF has not dedicated to the logistics activities of the program the appropriate number of personnel, partially because of actual limited resources and short term planning, but mainly because of the failure in understanding the opportunity of savings that the ILS approach could determine in terms of total life cycle costs.

This traditional logistics concept that still characterizes the IAF executive managers constitutes, in the author's opinion, the main barrier to a more successful implementation of the ILS methodology.

Contractual Logistics Incentives. The study has highlighted that one of the main technical difficulties encountered in logistics acquisition programs is a clear quantification of logistics goals (29, 37).

The EFA project has obtained a major success in the definition of reliability, maintainability, and testability requirements in a way that allows their inclusion under incentive contracting arrangements.

Unfortunately, some practical results have not been achieved in any of the other ILS disciplines. LSA, material support, AGE, technical publications, ground crew training and facilities are, in fact, presently covered by budgetary arrangements. Their conversion into incentive contracting packages ought "to ensure that they are treated as equal components of the main contracts and to prevent further damaging cuts through budgetary restrictions" (34:B.3).

It seems that the ATF approach should get more satisfactory results, emphasizing the incentive policy of a percentage to be gained by industry on a 6-month basis well beyond the R & M design characteristics (30).

On the other hand it is useful to specify that the introduction of incentives in the contractual framework of the EFA program represented a totally new approach for the inflexible contractual regulations of the Italian MOD. It was very difficult for the Italian contracting officers justifying the expenditure of public money for the achievement of results that went beyond the requirements contained in the specifications. The need for updating some legal aspects of military contracting to the standards required by international fully cooperative programs speeded up the acceptance of the philosophy of incentives.

In the same context, to make the problem worse, the EFA prime contractors have shown reluctance to accept the customer's offers of greater profit possible with the R, M & T incentives, in spite of the fact that, if successfully achieved, the minimization of life cycle costs should give Eurofighter and Eurojet a better position in the competitive market for further sales (34:B.2).

The recommendation is that the IAF exhort the partner air forces to convert the current budgetary agreements that regulate LSA, material support, support equipment, technical publications, and groundcrew training and facilities into incentive contracting packages. This approach should be included in the production investment, production, and in-service contracts.

ILS Standards. The study, in all the areas investigated, has stressed the importance of standardization in acquisition logistics procedures, regulations and facilities. The ALD lessons learned data base and the acquisition review group study have provided a variety of actual examples and feasible proposals in the DOD environment, where full standardization has not yet achieved, but great progress is on the way, especially in the automated systems (3, 5, 10, 14, 30).

The problem is exceptionally enlarged in the EFA context. The multinational characteristic of the program has not allowed the full adoption of the American ILS standards, emphasizing at the same time the lack of existing common logistics procedures and facilities among the European countries.

One of the major challenge of the EFA project will be the integration of some American military standards fully adopted from the beginning of the program, such as the R & M and LSA ones, with the first AECMA (Aircraft European Contractors Manufacturers Association) standards, recently developed within the European Community to satisfy this need of standardization. In particular, the just born AECMA 2000 standard for material support, which will be adopted for the first time in the EFA project, must be married pretty soon with the LSA MIL-STD-1388-1A/2A, if consistent results are to be achieved during the current development phase (34:B.4).

The IAF should make its best efforts to overcome the currently experienced difficulties supporting the work that the Royal Air Force (RAF) has already accomplished in this area and preparing the introduction in the IAF of the combined US/European standards that must be used already in the initial provisioning quantification.

Funding for the update of the current ADP systems used by the TORNADO supply support to the AECMA 2000 standard requirements is shared between the EFA and TORNADO projects under the combined management of NAMMA and NEFMA (34:B.5). In this case, maximum pressure should be put by the IAF on the two NATO agencies to avoid program delays that could not be recovered afterwards. This combined use of supply procedures and automated systems for the two weapon systems is a clear example of the possible outcomes both in efficiency and effectiveness resulting from the adoption of common regulations and tools. Under this perspective, the IAF should strongly support in the next future the adoption of commercial logistics software packages for the ADP tools required to accomplish the functional activities of the ILS disciplines. This successfully happened with the Enhanced Procurement System (EPS) that, built on components used in industry, was finally accepted after reducing the original idea of vigorous tailoring of material supply standards. Too many project peculiarities, in fact, would have imposed the development of a totally new system from scratch with prohibitive costs and difficulties (34:B.5).

LCC Techniques. The USAF widely uses life cycle cost (LCC) techniques in its acquisition programs, as outlined by the ALD lessons learned data base and the ATF current situation (3, 30). Although NEFMA has recently recognized the urgency of a full reappraisal of the ILS use of LCC modeling, the contractors continue to fail to make successful and active use of these techniques (34:B.5).

Also the LCC modeling, as the LSA process, was never adopted by the IAF in a previous weapon system acquisition. A full understanding of its importance to demonstrate how changes to design could impact on the overall costs certainly would help provide firm belief of the need of its timely adoption.

The TORNADO Logistics Problems within the EFA ILS Approach. As already mentioned at the end of Chapter III, attention to logistics matters came too late in the TORNADO program and there was insufficient impact on design for supportability followed by inadequate time to provide the necessary level of support. The ILS framework decided by the nations for the EFA program was designed to avoid the major logistics shortfalls of the TORNADO project, but still further actions are necessary to achieve higher benefits from the global support philosophy.

The contractual framework of the TORNADO project failed to give first priority to well-defined logistics requirements in all the phases of the program, with the result of very high operating costs. The EFA development contracts encompass ILS requirements up to the Production Investment (PI) release milestones, but "the artificial limitation of the ILS contract ... has added complications" (34:A.2). ILS contracting for the further phases must be carefully planned to ensure the realization of the ILS aims and select the most appropriate form of pricing and contractual arrangements. Till the current phase, the inability

> to define ILS requirements in finite terms other than for reliability, maintainability, and testability (RM&T), has meant the exclusion of many ILS aspects from incentive pricing arrangements. Against the background of fixed price and fixed performance contracts, ILS aspects not covered by the same incentives remain at risk. (34:4-5)

In the TORNADO project, long term in-service support and export sales arrangements were not established in early Memorandum of Understanding (MOU) negotiations, creating conflicts and problems in the following years. Some of these issues have been taken into consideration in the very early EFA MOUs, allowing essential planning to proceed, but further MOU work is needed, especially in the area of contingency plans for "the diversion of ILS effort to support a major sale during the early in-service years" (34:A.2), if the nations do not want to jeopardize their ILS needs.

The TORNADO program sometimes sacrificed commonality aims "in favour of short-term expediency or economy" (34:A.2), failing to take advantage of opportunities for economies of scale with direct impact on support costs. The same mistake seems to be repeated in the EFA program, where already from the beginning of the project the air forces have shown little propensity to renounce national minor requirements in the name of commonality.

The TORNADO support was managed without an integrated Automated Data Processing (ADP) philosophy: ADP tools were introduced only through the years, thus duplicating effort and incompatibility of systems among air forces and industries. The EFA program, born to operate in the new century, started with very clear ideas about the determination of management requirements for ADP, studying the needs of customer and contractor in order to establish "a common ADP structure and any joint and individual components of such a structure" (34:A.3). Despite these excellent intentions, both nations and industry underestimated the task, probably failing to understand the significance of the early definition of ADP data standards and the complexity of the problem. In 1989 the writer was the Italian representative at the EFA Logistics ADP Group and personally experienced the scarce attention given to this issue within the broad logistics field. The panel was constituted by air force and industry specialists who were not able to understand or represent to higher level the managerial importance of the logistics ADP structure within the ADP architecture of the entire project. Some recovery actions have been identified and partially introduced, but a full remedial strategy has not been decided.

Directly related to the ADP support issue is the Initial Provisioning (IP) data problem. TORNADO was characterized by "repetition of the data collection, amendment or reissue of Illustrated Parts Catalogues, procurement of superseded items, redundancy of stock and configuration management chaos" (34:A.4). EFA has planned to collect data using ADP means and integrate them with the data of the other ILS disciplines, under a strict configuration management. Improvements in forecasting of spares should come from the application of LSA, whereas better quality of data should be possible with the recording and analysis of development and flight test maintenance and consumption data collected by industry, as an integral part of ILS. The air forces shall pay special attention to the selection and training of the IP teams and to their own quantification algorithms to be applied to the data.

The TORNADO experience of in-service support problems, due to the instability of design of some of the more complex equipment at the logistics support date (LSD), was the main reason for the contractual proviso of the flexible phased support option discussed in Chapter III. It is too early to evaluate the impact of this strategy on the in-service support, but, at least in the equipment selection process and following contractual negotiations, ILS requirements received the needed attention and were properly covered, as the author personally experienced by participating in the EFA Equipment Selection Panel from January 1989 to May 1990.

Probably the toughest problem of the TORNADO service units was the enormous number of modifications which made configuration management an incredibly complex task. These units, such as the IAF 1st Reparto Manutenzione Velivoli (TORNADO Depot), often discovered that

> they had an inappropriate standard of line replaceable items (LRI) which was either incompatible with the aircraft fit or which had a compatibility which could not be established; they could not repair LRIs or modules because the repair spares had been superseded; and even when they had the correct materiel, the lack of technical publications, facilities and personnel training standards often frustrated their efforts. (34:A.5)

The counteraction to this plague is the EFA modification procedures that have been written in the simplest but most rigorous way in order to allow a fully automated configuration management.

The TORNADO program experienced very high costs for technical publications: estimates on the order of 2% of overall acquisition costs clearly indicate that it is time to introduce automation also in this specific logistics sector. EFA will have a Common Source Data Base (CSDB) from which modular assembly of the required documents will be possible. Also the distribution, use and updating of the publications is expected to occur entirely via electronic media; improvements in time, configuration and costs should cause higher efficiency and effectiveness (34:A.5).

Related to technical publication and material support is also the problem of NATO cataloging procedures that caused complexity and confusion in the TORNADO project. To avoid proliferation of spares within customer inventories, EFA should have simplified and flexible codification procedures (34:A.6).

Finally, the TORNADO transportation and distribution system worked exceptionally well in the difficult international environment of the program. In this case the same infrastructure will be established for the EFA program, with similar "operating procedures, customs arrangements and co-ordination of distribution" (34:A.6).

VI. Conclusions and Recommendations

Conclusions

This study has provided a wide overview of the ILS philosophy and implementation, specifically focusing on the USAF experience in acquisition logistics and the lessons learned from the TORNADO program, where lack of a global logistics approach primarily contributed to extremely high operating and support costs.

The research has been conducted with the objective of providing recommendations for the IAF to use in the EFA program, but also looking for general guidelines applicable to the Italian acquisition logistics environment.

The major conclusions of the study can be summarized in the following four observations.

1. The ILS concept and the LSA methodology have achieved within the USAF positive results that, however, are a small percentage of the potential effectiveness and cost savings reasonably expected from the logistics scholars.
2. The reasons for this only partial success are well known to the USAF, namely specific deficiencies in the acquisition logistics management organization, limited integration of logistics into system engineering, insufficient acquisition logistics education, and shortfalls in the LSA tailoring and application. Although the appropriate corrective actions were

identified some years ago, the problem still remains in their implementation.

3. The actual solution, that is the full commitment of the USAF executive managers, has not been achieved yet. Despite the current reduction in available resources, in fact, they should provide higher priority to acquisition logistics problems. Recent initiatives and new weapon system acquisition programs seem to indicate renewed interest and effort for an active logistics policy.

4. The ILS approach followed by UK, GE, IT and SP in the definition of the logistics requirements for the EFA project is substantially correct. The logistics parts of the EFA development contracts were, in fact, prepared ver_ carefully, following criteria fully in line with the current American acquisition programs and including additional features, such as the flexible phased support option.

Recommendations

The research findings, based on the USAF ILS experience and the TORNADO traditional logistics approach, suggest numerous recommendations that the IAF could take into consideration in the next phases of the EFA project and, in general, in the future weapon system acquisition programs.

The major indications are summarized in the following six suggestions.

1. The IAF should make its maximum effort in preparing the introduction of all new concepts, systems, and procedures that will characterize the EFA support. Particular emphasis should be given to personnel education in acquisition logistics, and development and procurement of automated systems for logistics management.

2. The computerization of all logistics functions and the transmission of electronic data under military regulations are the first requirements for an integrated management of all logistics disciplines. The IAF should pay the highest attention to the CALS philosophy that is aiming at the integration of independent logistics and engineering data bases in order to allow a single terminal to have access to multiple sources of information. This is the appropriate time for the IAF to design and implement automated systems that will be able to communicate and exchange data each other, through the use of relational data bases. To be prepared for an effective use of such revolutionary facilities, the IAF must improve its current limited data collection system and make larger use of statistical techniques. Also the establishment of a logistics lessons learned data base similar to the ALD system could provide a useful tool able to give updated information in both the managerial and technical activities of the IAF.

3. NEFMA has clear ideas on how to make a beneficial use of the TORNADO logistics deficiencies in the EFA project. The IAF should become a prime actor in the discussion and solutions of these logistics problems in the international bodies, avoiding that stronger partners model decisions to their own requirements.
4. Maximum priority should be given to the planning of ILS contracting for the further phases of the EFA project, providing the basis for the realization of the ILS objectives and selecting the most appropriate form of pricing and contractual arrangements. The IAF should convert the current budgetary agreements that regulate LSA, material support, support equipment, technical publications, and ground crew training and facilities into incentive contracting packages, already from the next production investment contract.
5. The IAF should understand the fundamental importance of the integration of the ILS standards selected for the EFA project. A manifest example is the necessary urgent marriage of the LSA MIL-STD-1388-1A/2A (American standard) with the material support AECMA 2000 (European standard), a 'conditio sine qua non' for the prosecution of the program, as soon as the initial provisioning will start.
6. The IAF should improve its current policy in the use of its limited number of experts in acquisition logistics. Officers at the completion of their service in NEFMA

should be assigned to appropriate positions in which they could exercise their knowledge in the following logistics steps of the program. Also the authority provided to the ILS manager should be enlarged in order to give him the power to make important decisions and the instruments to implement the logistics plans within the air force. This is also the last possibility to sustain the functions of the logistics team located at each of the main contractors' sites, if fruitful utilization of this resource is expected for all the remaining part of the development phase.

A final comment is probably useful to understand the idea that originated this thesis. The author was looking for a successful acquisition logistics model used within the USAF to introduce in the IAF in conjunction with its first ILS experience. The research clearly stated that this model does not exist.

On the other hand, the study allowed the author to understand how a huge and modern air force lives its acquisition logistics reality and to identify some recommendations that, if accepted and combined with the indications provided by the traditional TORNADO logistics experience, could shorten the learning period of the ILS process within the IAF.

Appendix A : LSA Tasks and Subtasks

General Information

This appendix provides the full list of the tasks and subtasks which are described in MIL-STD-1388-1A Logistics Support Analysis (LSA).

LSA Sections, Tasks, and Subtasks

Task Section:
    100 - Program Planning and Control

Tasks/Subtasks:
    101 - Development of an Early LSA Strategy
        101.2.1 - LSA Strategy
        101.2.2 - LSA Strategy Updates
    102 - LSA Plan
        102.2.1 - LSA Plan
        102.2.2 - LSA Plan Updates
    103 - Program and Design Reviews
        103.2.1 - Establish Review Procedures
        103.2.2 - Design Reviews
        103.2.3 - Program Reviews
        103.2.4 - LSA Reviews

Task Section:
    200 - Mission and Support Systems Definition

Tasks/Subtasks:
    201 - Use Study
        201.2.1 - Supportability Factors
        201.2.2 - Quantitative Factors
        201.2.3 - Field Studies
        201.2.4 - Use Study Report and Updates
    202 - Mission Hardware, Software, and Support System Standardization
        202.2.1 - Supportability Constraints
        202.2.2 - Supportability Characteristics
        202.2.3 - Recommended Approaches
        202.2.4 - Risks
    203 - Comparative Analysis
        203.2.1 - Identify Comparative System
        203.2.2 - Baseline Comparison System
        203.2.3 - Comparative System Characteristics
        203.2.4 - Qualitative Supportability Problems
        203.2.5 - Supportability, Cost, and Readiness Drivers

203.2.6 - Unique System Drivers
203.2.7 - Updates
204 - Technological Opportunities
204.2.1 - Recommended Design Objectives
204.2.2 - Updates
204.2.3 - Risks
205 - Supportability and Supportability Related Design Factors
205.2.1 - Supportability Characteristics
205.2.2 - Supportability Objectives and Associated Risks
205.2.3 - Specification Requirements
205.2.4 - NATO Constraints
205.2.5 - Supportability Goals and Thresholds

Task Section:
300 - Preparation and Evaluation of Alternatives

Tasks/Subtasks:
301 - Functional Requirements Identification
301.2.1 - Functional Requirements
301.2.2 - Unique Functional Requirements
301.2.3 - Risks
301.2.4 - Operations and Maintenance Tasks
301.2.5 - Design Alternatives
301.2.6 - Updates
302 - Support System Alternatives
302.2.1 - Alternative Support Concept
302.2.2 - Support Concept Updates
302.2.3 - Alternative Support Plans
302.2.4 - Support Plan Updates
302.2.5 - Risks
303 - Evaluation of Alternatives and Tradeoff Analysis
303.2.1 - Tradeoff Criteria
303.2.2 - Support System Tradeoffs
303.2.3 - System Tradeoffs
303.2.4 - Readiness Sensitivities
303.2.5 - Manpower and Personnel Tradeoffs
303.2.6 - Training Tradeoffs
303.2.7 - Repair Level Analyses
303.2.8 - Diagnostic Tradeoffs
303.2.9 - Comparative Evaluations
303.2.10 - Energy Tradeoffs
303.2.11 - Survivability Tradeoffs
303.2.12 - Transportability Tradeoffs

Task Section:
    400 - Determination of Logistics Support Resource Requirements

Tasks/Subtasks:
- 401 - Tasks Analysis
    - 401.2.1 - Task Analysis
    - 401.2.2 - Analysis Documentation
    - 401.2.3 - New/Critical Support Resources
    - 401.2.4 - Training Requirements and Recommendations
    - 401.2.5 - Design Improvements
    - 401.2.6 - Management Plans
    - 401.2.7 - Transportability Analysis
    - 401.2.8 - Provisioning Requirements
    - 401.2.9 - Validation
    - 401.2.10 - ILS Output Products
    - 401.2.11 - LSAR Updates
- 402 - Early Fielding Analysis
    - 402.2.1 - New System Impact
    - 402.2.2 - Sources of Manpower and Personnel Skills
    - 402.2.3 - Impact of Resource Shortfalls
    - 402.2.4 - Combat Resource Requirements
    - 402.2.5 - Plans for Problem Resolution
- 403 - Post Production Support Analysis
    - 403.2 - Post Production Support Plan

Task Section:
    500 - Supportability Assessment

Tasks/Subtasks:
- 501 - Supportability Test, Evaluation, and Verification
    - 501.2.1 - Test and Evaluation Strategy
    - 501.2.2 - Objectives and Criteria
    - 501.2.3 - Updates and Corrective Actions
    - 501.2.4 - Supportability Assessment Plan (Post Deployment)
    - 501.2.5 - Supportability Assessment (Post Deployment)

Appendix B : LSA Data Records

General Information

This appendix provides the full list of the LSA Data Records and LSAR Reports which are described in MIL-STD-1388-2A DOD Requirements for a Logistics Support Analysis Record.

LSA Data Records

Data Record A	Operation and Maintenance Requirements
Data Record B	Item Reliability (R) and Maintainability (M) Characteristics
Data Record B1	Failure Modes and Effects Analysis
Data Record B2	Criticality and Maintainability Analysis
Data Record C	Operation and Maintenance Task Summary
Data Record D	Operation and Maintenance Task Analysis
Data Record D1	Personnel and Support Requirements
Data Record E	Support Equipment and Training Material Description and Justification
Data Record E1	Support Equipment and Training Material Description and Justification (continued)
Data Record E2	Unit under Test Description and Justification
Data Record F	Facility Description and Justification
Data Record G	Skill Evaluation and Justification
Data Record H	Support Items Identification
Data Record H1	Support Items Identification (Application Related)
Data Record J	Transportability Engineering Characteristics

LSAR Reports

LSA-001	Direct Annual Maintenance Manhours by Skill Specialty Code and Level of Maintenance
LSA-002	Personnel and Skill Summary
LSA-003	Maintenance Summary
LSA-004	Maintenance Allocation Summary
LSA-005	Support Item Utilization Summary
LSA-006	Critical Maintenance Task Summary
LSA-007	Support Equipment Requirements
LSA-008	Support Items Validation Summary
LSA-009	Support Items List
LSA-010	Parts Standardization Summary
LSA-011	Requirements for Special Training Device
LSA-012	Requirements for Facility
LSA-013	Support Equipment Grouping Number Utilization Summary
LSA-014	Training Task List

LSA-015	Sequential Task Description
LSA-016	Preliminary Maintenance Allocation Summary
LSA-017	Preliminary Maintenance Allocation Summary Tool Page
LSA-018	Visibility and Management of Operating and Support Cost (VAMOSC) Summary
LSA-019	Maintenance Task Analysis Validation Summary
LSA-020	Tool and Test Equipment Requirement
LSA-021	Task Referencing List
LSA-022	Referenced Task List
LSA-023	Maintenance Plan Summary
LSA-024	Maintenance Plan
LSA-025	Packaging Requirements Data
LSA-026	Packaging Development Data
LSA-027	Failure/Maintenance Rate Summary
LSA-028	Reference Number/Additional Reference Number Cross Reference List
LSA-029	Repair Parts List
LSA-030	Special Tools List
LSA-031	Part Number/National Stock Number/Reference Designator Index
LSA-032	Defense Logistics Services Center (DLSC) Submittals
LSA-034	Stockage List Type Four
LSA-036	Provisioning Requirements
LSA-040	Components of End Item (COEI) List
LSA-041	Basic Issue Items (BII) List
LSA-042	Additional Authorization List (AAL)
LSA-043	Expandable/Durable Supplies and Materials List (ESML)
LSA-045	Stockage List Type Three
LSA-050	Reliability Centered Maintenance (RCM) Summary
LSA-051	Reliability Summary-Redesign
LSA-052	Criticality Analysis Summary
LSA-053	Maintainability Analysis Summary-Level of Repair
LSA-054	Failure Mode Analysis Summary
LSA-055	Failure Mode Detection Summary
LSA-060	LSA Control Number Master File
LSA-061	Parts Master File
LSA-070	Support Equipment Recommendation Data (SERD)
LSA-072	Test Measurement and Diagnostic Equipment (TMDE) Requirements Summary
LSA-074	Support Equipment Tool List
LSA-075	LSAR Manpower Personnel Integration (MANPRINT) Summary
LSA-077	Depot Maintenance Interservice Data Summary
LSA-080	Bill of Materials
LSA-100	Chronolog Information
LSA-101	Transaction Edit Results - Selection Cards
LSA-102	Transaction Edit Results - LSA Control Number (LCN) Master
LSA-103	Transaction Edit Results - Parts Master
LSA-104	Transaction Edit Results - Narrative master

LSA-105	Key Field Change Transactions
LSA-106	Reference Number Discrepancy List
LSA-107	LCN-Task Identification Code Cross Reference List
LSA-108	Critical Data Changes
LSA-109	Unidentified Transactions
LSA-150	Provisioning Error List
LSA-151	Provisioning Parts List Index (PPLI)
LSA-152	PLISN Assignment/Reassignment
LSA-154	Provisioning Part Breakout Summary
LSA-155	Recommended Spare Parts List for Spares Acquisition Integrated with Production (SAIP)

Appendix C : LSA Questionnaire

General Information

The following questionnaire was developed by the LSA Acquisition Review Group to evaluate the status of the application of the LSA process within the USAF in 1986. Presented as an appendix of the final report of the study (17:38-59), the questionnaire was intended for all respondents, but it included also special sections dedicated to contractors, developers, supporters, and users (14:3).

General Questionnaire

1) Program/office/organization visited:

2) Name/position/specialty/phone:

3) Interviewer:

4) Current Phase of Acquisition:
   A. Conceptual
   B. Demonstration/Validation
   C. Full Scale Development
   D. Production/Deployment
   E. Post Production
   F. Class IV Modification
   G. Class V Modification

5) Was Logistics Support Analysis (LSA) applied?
   A. Yes
   B. No

6) When was LSA first applied?
   A. Conceptual
   B. Demonstration/Validation
   C. Full Scale Development
   D. Production/Deployment
   E. Post Production
   F. Modification

7) Were Logistics Support Analysis Records (LSAR) created?
   A. Yes
   B. No

8) Please rate the effectiveness of LSA/LSAR on your program:
   A. Very effective
   B. Somewhat effective
   C. Marginally effective
   D. Ineffective
   E. Unknown

9) Does LSA influence design?
   A. Yes
   B. No

10) Does LSA improve supportability?
   A. Yes
   B. No

11) What agencies participate in the LSA process?
   A. Government Program Office
   B. Contractor Program Office
   C. Supporting Air Logistics Center
   D. Using Command Representatives
   E. AFOTEC Personnel
   F. AGMC Personnel
   G. ATC Personnel
   H. Other Service Personnel

12) How was MIL-STD-1388-1A tailored for this program? What tasks were specifically required?

13) Did you have adequate experienced logistics manpower to properly support the LSA process?
   A. Yes
   B. No

14) Did you have adequate experienced engineering manpower to properly support the LSA process?
   A. Yes
   B. No

15) Did you evaluate the LSA generated reports and provide adequate inputs/direction to the contractor?
   A. Yes
   B. No

16) Was this evaluation manpower intensive?
   A. Yes
   B. No

17) On a scale of A (not effective) to E (highly effective), how effective are LSA output reports for the following resource requirements:

Facilities:	A	B	C	D	E
Personnel:	A	B	C	D	E
Training:	A	B	C	D	E
Support Equipment:	A	B	C	D	E
Spares:	A	B	C	D	E
Manpower:	A	B	C	D	E

18) Are you using LSA in the Life Cycle Management Process?
A. Yes
B. No

19) Estimate the number of manyears expended on LSA for this program.

20) Physically, are the logistics and engineering staff combined?
A. Yes
B. No

21) Are there organizational policies and initiatives which stimulate interaction between logisticians and engineers throughout the course of the program?
A. Yes
B. No

22) Organizationally, what activity is responsible for LSA?

23) Will system Program Management Responsibility Transfer (PMRT)?
A. Yes
B. No

24) Are LSA records used and updated by using support commands?
A. Yes
B. No

25) Which Air Force management information system should interface with LSA?

26) Can you identify the true LSA cost on your program?
A. Yes
B. No

27) If so, how much was the cost?

28) Can you identify the dollar value of benefits of LSA on your program?
A. Yes
B. No

29) If so, what was the value of the benefits?

Next, go to the Special Questionnaire section and complete all that are applicable to you:

- a. Contractor, SPO, ALC
- b. Contractor
- c. Using Command
- d. AFOTEC
- e. Mission Critical Computer Resources Software Specialists
- f. Automated Data System
- g. Support Command
- h. Training Command (ATC)

After completing this section, please complete questions 30-45.

30) Please specify any and all courses which included any LSA that you attended prior to assuming your present job. Please include course number and training location. If NONE was taken, please indicate.

31) If you worked with LSA/LSAR on other programs, please identify the program and the duration of your assignment.

32) If you feel your training in LSA/LSAR was lacking when you assumed your present job, please indicate the major areas of training deficiencies.

33) What do you feel is the minimum LSA training/education/experience required for effectiveness in your job? Why?

34) If an organic LSA/LSAR training program has been established, what manpower, resources, facilities, time, etc. have been devoted? (Are copies of curriculum available?)

35) Are personnel dealing with the LSA/LSAR process adequately trained?

- A. Yes
- B. No
  - a. If no, how do you recommend personnel attain LSA/LSAR skill and knowledge levels, through in-house training or through a formal Air Force course?
  - b. If yes, how did they attain their skill and knowledge level?

36) Do you feel training in any other areas should be prerequisite to LSA training? (This prerequisite training could be an inherent part of the LSA training.)

37) Is there a need for recurring training? If so, what kind of training and to what skill/knowledge level?

38) When you assumed your present job, did you feel your training and experience were adequate to effectively manage your area of LSA responsibility?
   A. Yes
   B. No

39) How long after taking your current job, did you feel you had adequate knowledge and experience to effectively handle LSA?
   A. Immediately
   B. 1-6 Months
   C. 6-12 Months
   D. 12-18 Months
   E. 18-36 Months
   F. Over 36 Months

40) Were LSA training/education/experience used as criteria for selecting you for your present job?
   A. Yes
   B. No

41) What types of warranties are used on your program?
   A. System Level
   B. Component Level
   C. Reliability Improvement Warranties (RIW)
   D. Maintainability Improvement Warranties (MIW)

42) What LSA data is applicable to warranty administration for your type of program?

43) What is the impact of warranties on logistics support concepts and LSA? (impact of delaying organic support due to early warranty coverage)

44) If you did not have LSA, how would you incorporate supportability into your design?

45) If there is one thing you could do to improve LSA, what would it be?

Specialized Questionnaire for Contractors, SPOs, ALCs

Answer the following questions only if you are a contractor, an Air Force Special Projects Office, or an Air Logistics Center (ALC)

1) What type of LSAR system was used?
   A. Government
   B. Contractor

2) What type of system was used?
   A. Type 1
   B. Type 2
   C. Type 3

3) Was your system validated IAW with MIL-STD-1388-1A?
   A. Yes
   B. No

4) Is LSA an integral part of your system engineering process?
   A. Yes
   B. No

5) Did you get any other CDRL items which could have been satisfied by the LSAR?
   A. Yes
   B. No

6) How was LSA/LSAR included in the contract?
   A. System Specification
   B. Statement of Work
   C. Contract Data Requirements List

7) What was the government access to the LSAR? Indicate all answers applicable to your program.
   A. Through Delivery of Master Files
   B. Through delivery of CDRL Records
   C. Through Data Accession List
   D. By "Read Only" Contractor Access to Records
   E. By interactive Creation of Reports from Master File
   F. None of the Above

8) Did contract require LSA to be part of system engineering effort?
   A. Yes
   B. No

9) Did the contract specifically require that the LSA documentation be maintained to serve as the single point data base for ILS resource requirements?
   A. Yes
   B. No

10) Please indicate the revision of LSA used on this contract.
   A. MIL-STD-1388-1A
   B. MIL-STD-1388-2A
   C. MIL-STD-1388-1
   D. DARCOM P-750-16
   E. Other System

11) Were adequate funds programmed to support the LSA process?
   A. Yes
   B. No

12) Was LSA used to evaluate alternative technologies?
   A. Yes
   B. No

13) What impacts did technology have on LSA?

14) What impacts did LSA have on technology?

15) What percentage of your program consisted of Commercial Off-the-Shelf equipment?
   A. None
   B. 1-25%
   C. 25-50%
   D. 50-99%
   E. All

16) Was LSA applied to the Commercial Off-the-Shelf equipment?
   A. Yes
   B. No

17) What percentage of your program consisted of Modified Commercial Off-the-Shelf equipment?
   A. None
   B. 1-25%
   C. 25-50%
   D. 50-99%
   E. All

18) Was LSA applied to the Modified Commercial Off-the-Shelf equipment?
   A. Yes
   B. No

19) What percentage of your program consisted of Off-the-Shelf technology?
- A. None
- B. 1-25%
- C. 25-50%
- D. 50-99%
- E. All

20) Was LSA applied to the Off-the-Shelf technology?
- A. Yes
- B. No

21) What percentage of your program consisted o[illegible]vernment Furnished Equipment?
- A. None
- B. 1-25%
- C. 25-50%
- D. 50-99%
- E. All

22) Was LSA applied to the Government Furnished Equipment?
- A. Yes
- B. No

23) Was LSA used on COTS/MODCOTS/GFE/OTST on your program?
- A. Yes
- B. No

24) Did it differ from other system development requirements?
- A. Yes
- B. No

25) Were there separate data sheets/analyses required?
- A. Yes
- B. No

26) Is LSAR data to be delivered during the present phase of this program?
- A. Yes
- B. No

27) In what media is LSA/LSAR data delivered?
- A. Tape/Disk
- B. Hard Copy
- C. Record Sheet Format

28) What happens to LSAR data upon contract phase completion?

Specialized Questionnaire for Contractors Only

1) Is there a better way to get supportability other than LSA?
   A. Yes
   B. No

2) Was the LSA/LSAR program effectively administered by Air Force personnel?
   A. Yes
   B. No

3) Is there clear regulatory guidance on LSA/LSAR by the Air Force?
   A. Yes
   B. No

4) Are Air Force agencies effectively utilizing LSA/LSAR outputs?
   A. Yes
   B. No

Using Command Questionnaire

1) Do you have a need to know LSA on your program?
   A. Yes
   B. No
      If no, how do you assure supportability?

2) Where is your LSA OPR functionally aligned?

3) What specific job areas (AFSCs) need LSA training?

4) To what skill or knowledge level should this training address?

5) Did LSA adequately identify logistics supportability requirements? (ILS elements)

	Yes	No
Training	___	___
Facilities	___	___
Tech Orders	___	___
Support Equipment	___	___
Supply Support (Spares)	___	___
Manpower	___	___
PHS&T	___	___
Design Interface	___	___
Maintenance Planning	___	___
Computer Resource Support	___	___

6) Since there is a lack of LSA formal training within the Air Force, does the contractor have an unfair advantage over the user?

7) How much time within your program is devoted to reviewing LSAR data prior to an LSAR data review?

8) When you need questions answered concerning LSA who is your point of contact?

AFOTEC Questionnaire

1) Do you have a need to know LSA?
   A. Yes
   B. No

2) Where is your LSA OPR functionally aligned?

3) What specific job areas (AFSCs) need LSA training?

4) To what skill or knowledge level should this training address?

5) Who provides your LSA training?

6) Do you attend LSAR data reviews?
   A. Yes
   B. No
      If no, why?

7) When you need questions answered concerning LSA who is your point of contact?

Specialized Questionnaire for Mission Critical Computer Resources/Software

1) If the Life Cycle Cost Analysis included MCCR software support costs, where was the data obtained? What factors were considered in determining the LCC?

2) How were MCCR software support requirements identified, including facilities, equipment, supplies, and training?

3) How were manning skills for MCCR software support identified?

4) If the contract specifies R & M requirements, how are they verified?

5) If the current LSA format is not adequate to accomplish the required MCCR software support analysis, what changes do you recommend?

6) What documents and data items, described in DOD-STD-2167, are applicable to the LSA process?

7) What changes need to be made to MIL-STD-1388 and DOD-STD-2167 in order to harmonize software development (2167) and LSA (1388)?

8) How can LSA influence the determination of the software support concept?

9) How can LSA influence the Computer Resources Life Cycle Management Plan?

10) How can LSA influence the Operational/Support Configuration Management Plan?

11) Did the contract require LSA during software development?
A. Yes
B. No

12) Is the LSA process an effective design tool for the software engineer?
A. Yes
B. No

13) Are software supportability paybacks, through implementing LSA, considered cost-effective?
A. Yes
B. No

14) Is the current LSA format adequate to accomplish the required software support analysis?
A. Yes
B. No

15) In light of the complete software development process in DOD-STD-2167, is LSA necessary for software?
A. Yes
B. No

16) Do MIL-STD-1388-1A tasks duplicate DOD-STD-2167 tasks?
A. Yes
B. No

17) Are there any tasks called for in MIL-STD-1388-1A which are not called for in DOD-STD-2167?
A. Yes
B. No

18) Should a software LSA data base be kept separate from the system LSA data base?
    A. Yes
    B. No

19) Did Life Cycle Cost Analysis, if performed, involve software support costs?
    A. Yes
    B. No

20) Did the contract specify a software R & M requirement?
    A. Yes
    B. No

Specialized Questionnaire for Support Command Personnel

1) Were regular LSA/LSAR reviews held?
    A. Yes
    B. No

2) Was there a formal schedule established for LSA meetings?
    A. Yes
    B. No

3) Was the contractor responsive in correcting LSAR deficiencies?
    A. Yes
    B. No

4) What are your greatest challenges in utilizing the LSA process Post PMRT?

5) Are resources a limiting factor in utilizing LSA/LSAR Post PMRT?
    A. Yes
    B. No
        If so, please explain.

Training Questionnaire for ATC

1) What are ATC's LSA/LSAR data requirements to support:
    A. Training Development
    B. Test & Evaluation

2) What is the impact if ATC doesn't receive the required data?

3) What are the benefits attained by ATC instructor personnel attending LSA/LSAR reviews?

4) How has LSA/LSAR supported ATC's mission in training development, and test and evaluation in past and present programs?

5) For the future, what could be changed in the LSA/LSAR to enhance ATC's training development, and efforts?

6) What problems have you identified in LSA/LSAR in past or present programs?

7) Did LSA adequately identify logistics supportability requirements? (ILS elements):

	Yes	No
Training	___	___
Facilities	___	___
Tech Orders	___	___
Support Equipment	___	___
Supply Support (Spares)	___	___
Manpower	___	___
PHS&T	___	___
Design Interface	___	___
Maintenance Planning	___	___
Computer Resource Support	___	___

8) What are your command's training requirements in LSA and how are they satisfied or are they being satisfied?

9) If the LSA/LSAR Acquisition Review Group's survey identifies a training void, how could ATC support a LSA/LSAR training program?

10) What resources would be required to support a LSA/LSAR training program?

11) How long would it take to develop a LSA/LSAR training program?

12) Who would be the responsible agency within ATC to develop LSA/LSAR training?

13) Where would this LSA/LSAR training be conducted?

Bibliography

1. Air Force Institute of Technology. Military Logistics, Chapter 5. Wright-Patterson AFB OH, May 1990.

2. Air Force Logistics Command. "Air Force Lessons Learned Program." Abstract, 6th Edition. Acquisition Logistics Division, Wright-Patterson AFB OH, October 1989.

3. -----. "Air Force Lessons Learned Program." Data base. Acquisition Logistics Division, Wright-Patterson AFB OH, continuously updated.

4. Air Force System Command. "ALMIS Program." Data base. Aeronautical System Division, Advanced Tactical Fighter System Program Office, Wright-Patterson AFB OH. Logistics Extract dated 22 January 1991.

5. Andrews, Richard A. "The Lombardi Approach to Integrated Logistics Support (ILS)," Air Force Journal of Logistics, 13: 1-6 (Winter 1989).

6. Blanchard, Benjamin S. Logistics Engineering and Management (3rd Edition). Englewood Cliffs NJ: Prentice-Hall Inc, 1986.

7. Bonifacio, Renato. Anni di Aeritalia. Rome, Italy: Nuovo Studio Tecna, 1991.

8. Brown, Michael. "ILS Supports the Program," Soldiers, 39: 32-33 (April 1984).

9. Cook, Thomas M. and Robert A. Russell. Introduction to Management Science (4th Edition). Englewood Cliffs NJ: Prentice-Hall Inc, 1989.

10. Crabtree, Jim W. and Ellis O. Atkinson. "Logistics Support Analysis (LSA): Enhancing the Process," Logistics Spectrum, 23: 17-21 (Fall 1989).

11. Craig, Samuel. "Logistics Support Analysis: an Integral Part of the System Engineering Process," Program Managers, 15: 9-18 (January-February 1986).

12. Department of the Air Force. Air Force Logistics Support Analysis Primer. AFLCP 800-17. HQ AFLC, Wright-Patterson AFB OH, 20 May 1988.

13. -----. Integrated Logistics Support (ILS) Program. AFR 800-8. HQ USAF, Washington DC, 25 June 1986.

14. -----. "Logistics Support Analysis Acquisition Review Group Final Report - Volume I." Report to HQ USAF Deputy Chief of Staff for Logistics and Engineering. HQ USAF/LEY, Washington DC, March 1987.

15. -----. "Logistics Support Analysis Acquisition Review Group Final Report - Volume II." Report to HQ USAF Deputy Chief of Staff for Logistics and Engineering. HQ USAF/LEY, Washington DC, March 1987.

16. -----. "Logistics Support Analysis Acquisition Review Group Final Report - Volume III, Data Analysis." Report to HQ USAF Deputy Chief of Staff for Logistics and Engineering. HQ USAF/LEY, Washington DC, March 1987.

17. -----. "Logistics Support Analysis Acquisition Review Group Final Report - Volume IV, Appendices." Report to HQ USAF Deputy Chief of Staff for Logistics and Engineering. HQ USAF/LEY, Washington DC, March 1987.

18. -----. Logistics Support Analysis User Guide. AFALC/ERL, Wright-Patterson AFB OH, March 1989.

19. Department of Defense. Acquisition and Management of Integrated Logistics Support for Systems and Equipment. DOD Directive 5000.39. Washington DC, 17 November 1983.

20. -----. DOD Requirements for a Logistics Support Analysis Record. MIL-STD-1388-2A. Washington DC, 20 July 1984.

21. -----. Logistics Support Analysis (LSA). MIL-STD-1388-1A. Washington DC, 11 April 1983.

22. Dorr, Oscar J. "Software Logistics," Logistics Spectrum, 18: 23-25 (Spring 1984).

23. Dunbar, Capt Paul A. A Computer Based Decision Support System for Tailoring Logistics Support Analysis (LSA) Contract Requirements. MS thesis, AFIT/GLM/LSY/88S-17. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1988 (AD-A202631).

24. EUROFIGHTER. EFA Logistic Support Program Plan. Document PL-J-O-E-0070, Issue C. Eurofighter, Munich, Germany, September 1988.

25. -----. EFA Weapon System Design and Performance Specification (WSDPS), Part III. Document EFJ-AVS-J-000-2001, Issue C. Eurofighter, Munich, Germany, July 1987.

26. Finocchio, Col Pietro (IAF). "La logistica dell'EFA." Unpublished conference addressed to the Italian Air Force War College students. Scuola di Guerra Aerea, Florence, Italy, 26 January 1990.

27. Harrison, Gerald L. Jr. "The Acquisition Logistician: a Case for New Education Programs in Logistics," Logistics Spectrum, 15: 9-14 (Spring 1981).

28. Heffner, Capt Michael G. A Computer Based Decision Support System (DSS) for Developing Logistics Support Analysis (LSA) Requirements as Part of the System Engineering Process. MS thesis, AFIT/GLM/LSM/89S-32. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1989 (AD-A214950).

29. Hull, Maj John R. and Capt Gregory L. Lockhart. Barriers to Fully Implementing Integrated Logistics Support (ILS) in System Acquisition as Perceived by ILS Managers and Program Managers at the Aeronautical System Division. MS thesis, LSSR 36-82. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1982 (AD-A122979).

30. Jirele, Lt Col David, Assistant Deputy Program Manager for Logistics. Personal Interview. Advanced Tactical Fighter System Program Office, Wright-Patterson AFB OH, 7 February 1991.

31. Jones, Myrtle B. and William C. Walker. "System Engineering and Logistics Support Analysis," Air Force Journal of Logistics, 11: 38-39 (Spring 1987).

32. McIlvane, Paul J. "The Real Need for Acquisition Logistics Education," Logistics Spectrum, 18: 13-16 (Spring 1984).

33. -----. "Software Logistics: a Sleeping Giant," Concepts, 5: 155-161 (Autumn 1982).

34. NATO EFA Development, Production and Logistic Management Agency. EFA Integrated Logistic Support Development Phase: Lessons Learned and the Way Ahead. Document E/1141/18000/0648. NEFMA, Munich, Germany, 11 September 1989.

35. -----. EFA Logistic Support Concept. Document 273/1/10/86/2, Issue A. NEFMA, Munich, Germany, 12 February 1986.

36. -----. Logistic Support Policy Statement for the European Fighter Aircraft. Document E/1141/18202/0320, Issue 2. NEFMA, Munich, Germany, 14 September 1990.

37. Niedever, Richard L. "Integrated Logistic Support and Design Influence," Logistics Spectrum, 21: 29-34 (Winter 1987).

38. Pierce, Capt Robert A. Tailoring the Tasks of Logistics Support Analysis (LSA). MS thesis, AFIT/GLM/LSQ/85S-64. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1985 (AD-A161681).

39. Royal Air Force. "The EFA Project." Unpublished report. CSDE/16570/1/365/88/MPE, Swanton Morley, Great Britain, August 1989.

40. Sancho Gonzales, Maj Carlos J. NATO Armaments Cooperation: the Case of the European Fighter Aircraft. MS thesis, AFIT/GSM/LSM/90D-25. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, December 1990 (AD-A230867).

41. Todd, Daniel and Jamie Simpson. The World Aircraft Industry. Dover MA: Auburn House Publishing Company, 1986.

42. "Who Will Do What on YF-22 Team," Dayton Daily News, April 28, 1991.

43. Wright, Andrea and Sandra L. Evans. "Do We Need LSAR for the Life Cycle of the Weapon System?" Unpublished Report. Acquisition Logistics Division, Wright-Patterson AFB OH, February 1991.

Vita

Lieutenant Colonel Pierluigi Ciardelli was born on 15 September 1954 in Florence, Italy. He joined the Italian Air Force (IAF) in 1973 entering the IAF Academy with the course named "Orione 3°." After receiving his degree in Electronic Engineering from the University of Naples in 1978, he became a registered professional engineer in 1979, and he graduated from the Air War College in 1984. He served as Chief of the Avionics Department of the 4th Wing Maintenance Depot in Grosseto, and then as Chief of the Italian delegation at MBB in Ottobrunn, Germany, where he was appointed as software Project Officer for the TORNADO program. Before entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1990, he served as Section Leader in the New Project Development Office of the Ispettorato Logistico 3° Reparto in Rome, where he worked in the logistics acquisition process of the EFA program. From 1988 to 1990 he participated in international meetings within NEFMA as a representative of the IAF at the Equipment Selection Panel and the Logistics ADP Group. In the same period he also taught Logistics at the Air War College.

Permanent address: Largo Claudio Monteverdi 14B/1
Cerveteri Valcanneto
I - 00050 Borgo S. Martino (Roma)
ITALY

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1991

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE
POTENTIAL IMPROVEMENTS IN THE LOGISTICS ACQUISITION PROCESS OF THE EUROPEAN FIGHTER AIRCRAFT: AN ITALIAN PERSPECTIVE

5. FUNDING NUMBERS

6. AUTHOR(S)
Pierluigi Ciardelli, Lieutenant Colonel, IAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology, WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/LSM/91S-9

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This thesis was aimed at developing recommendations to improve the implementation of the Integrated Logistics Support (ILS) concept and the application of the Logistics Support Analysis (LSA) tasks during the current acquisition of the European Fighter Aircraft (EFA) by the Italian Air Force (IAF). The research was conducted through a wide overview of the ILS philosophy and implementation, specifically focusing on the USAF experience in acquisition logistics and the lessons learned from the European TORNADO program in the area of support. Although a successful model ready to be introduced in the IAF was not found, some recommendations for the EFA program and some general guidelines applicable to the wider IAF acquisition logistics environment were identified and discussed. The aspects related to the personnel education in acquisition logistics, the computerization of all support functions, the emphasis on ILS contracting, and the integration of different logistics standards were the most significant findings applicable to the IAF. (25)

14. SUBJECT TERMS
Acquisition Logistics, European Fighter Aircraft ~~(EFA)~~ - Integrated Logistics Support ~~(ILS)~~ - ~~Italian~~ Air Force, ~~(IAF)~~ - Logistics Support Analysis ~~(LSA)~~, Theses.

15. NUMBER OF PAGES
123

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

AFIT Control Number AFIT/GLM/LSM/91S-9

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/LSC, Wright-Patterson AFB OH 45433-6583.

1. Did this research contribute to a current research project?

   a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Please estimate what this research would have cost in terms of manpower and/or dollars if it had been accomplished under contract or if it had been done in-house.

   Man Years ____________ $____________

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments

Name and Grade ____________ Organization ____________

Position or Title ____________ Address ____________